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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES' EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Registered Office and Laboratories of the B.C.I.R.A. are at:—
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Telephone: Central 1895. *Telegrams: CIRA.*
The B.C.I.R.A. Scottish Laboratories are:—
Foundry Technical Institute, Meek's Road, Falkirk (*Telephone* 332).

The B.C.I.R.A. Extensions.

The opening yesterday of the recently-extended laboratories of the British Cast Iron Research Association at Birmingham by Lord Rutherford marks another milestone in the Association's career. It would be useless to pretend that hitherto its accommodation or equipment have been worthy of a national body, or such as could be shown to foreign visitors with any real pride, but it is well known that the finding of capital for the purpose of providing these necessities has been a particularly difficult business. While the B.C.I.R.A. was early among the research associations to recognise the necessity for its own headquarters, and while the value of this has been abundantly proved during the past five years, other similar bodies, such as those dealing with the textile industries and non-ferrous metals, have been able to raise additional funds from their members or from other sources for the purpose of erecting buildings and equipping them. The circumstances of the trade during the past few years have prevented this in the case of the founding industry, and we hope that the opportunity to examine what has been done will serve to stimulate the imagination of those in the industry to conceive what value a properly-accommodated and equipped Association can do in the future.

We confess to some inability to understand why more founders do not take advantage of its services. It is true that times are bad and all expenditure, even productive expenditure, is rigidly curtailed. The subscription, however, is not a tax; it is returned with interest in services always available but never inconveniently pressed. There are very few foundries who can honestly say that the subscription cannot be saved several times over from the scrap pile alone. The truest economy in these days does not consist so much in saving as in securing the best return for money expended.

We shall give elsewhere an account of these laboratories, but we take this opportunity of congratulating the Association on the great improvement which they show and upon having secured Lord Rutherford, perhaps the most distinguished scientific figure of our time, officially to declare them open. The Association is doing incalculable good to the industry by its mere existence, for it forces on the attention of a wide variety of people in other walks of life and particularly in industry, the place and importance of founding in the community and thus help to give to the art a status commensurate with its value.

Foundry Nomenclature.

We probably handle more translations of foundry literature than any other person in Great Britain, and whilst, happily, we receive more praise than condemnation, we are acutely aware of the difficulties involved, difficulties in no way due to a lack of knowledge of either languages or foundry technique, but to the non-existence of adequate foundry nomenclature, Several years ago Dr. T. Swinden and Dr. P. Longmuir were prominent on a committee of the British Foundrymen's Association, which collected and published in the Proceedings of that body a selected list of definitions. The terms defined were mainly metallurgical and are easy of translation and understanding. The present-day requirement is a complete clarification of some of the newer expressions and a unification of older ones. Referring to the scoria, which floats to the surface of a metal from its interior, a foundryman for South Wales used in a Paper he read recently the word "scruff," whilst in his contribution to the recent Newcastle Conference, Mr. E. Longden employed the word "scum." Other writers called the same material "dross." The word "slag" is rarely used, and we consider rightly so, as this entity, to our mind, refers to a material which is or has been used for the carrying out of metallurgical reactions. We personally have not the slightest objection to standardising upon the word "scum," "scruff" or "dross," providing it refers to deleterious matter which floats upon liquid metal and which previously had been entangled within it. We, in introducing this subject used the word "scoria," but dislike the word as being related to ashes, and which has, to our mind, reference to material which has never reached the truly liquid state and floated upon some liquid metal.

Another piece of foundry plant which requires one appellation and not half-a-dozen, refers to a plate often of special contour or of baked bonded sand used for supporting cores during the baking process. It is called a "drier," "shell," "carrier" or combination of these words. The temperature at which these cores are dried is expressed by half the industry as being conducted at a certain Centigrade-scale reading and the other half in Fahrenheit degrees. We have noted confusion arising from this factor during discussions, and thought that some recommend practices and nomenclature might be advantageous. Thus we would appreciate rulings on git and gate, middle part and cheek, short run and check, draw and check; whilst definitions of false core, block pattern, slip flask, snap flask, the various types of gates, runners and risers. We suggest that this work is just the type of work which could be very usefully undertaken by the Technical Committee of the Institute of British Foundrymen, and so complete the excellent work initiated by Doctors Longmuir and Swinden.

XUM

A Novel Multiple Rotary Core Machine.

Major Athey, managing director of the Fordath Engineering Company, Hamblet Works, West Bromwich, has designed and protected by Patent Applications an extremely interesting and novel machine which shows that distinct strides have been made over the original forms of what is popularly known as the "sausage" core machine. This new development is illustrated in Fig. 1 and shows the machine engaged upon the simultaneous manufacture of ten cores of $\frac{3}{16}$ in. dia. The number of cores capable of being made in one operation is governed only by the accommodating capacity of the face of the die; moreover, the cores need not necessarily be of the same size, but can conform with the ascertained consumption of the moulders.

The cores as extruded are taken care of by hemispherical trough sections, which guarantees their absolute straightness, and as the troughs are held in position by a specially-designed

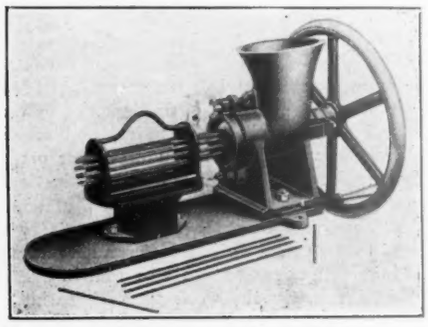


Fig. 1.—A New Multiple Rotary Core Machine making Ten $\frac{3}{16}$-in. dia. Cores Simultaneously.

carrier the adjustable platform of the earlier designs has been entirely obviated.

The new design only requires one conveyor to carry the sand to the die, whereas, previously, a series was required to cover the range of cores made; moreover, the vents of the core are now independent of the conveyor and rely upon the die itself, which ensures dead accuracy. The early types relied upon the vagaries of the vent pin for the accuracy of the vent-hole produced, and out-of-truth holes were by no means rare.

Jamming, recognised as one of the greatest difficulties with the earlier machines, has, it is claimed, been entirely overcome in the new designs, the shortness of the dies used being largely responsible. A notable feature of the new machine is the entire suppression of all gear wheels, which both speeds up production and reduces cost. The machine can produce cores of various shapes, square, oval, etc., with equal facility. It is obvious that a distinct advance has been made in core production by this rotary machine.

Publication Received.

"Sif-Tips," No. 1. Published by the Suffolk Iron Foundry (1920), Limited, Stowmarket. This house organ has been published with the object of bringing to its readers the latest developments and advances made in connection with oxy-acetylene welding, and particularly with respect to cast iron. On page 7 is an article of an elementary character, which outlines sufficient theory to show why iron castings should be pre-heated before welding, and why a high-silicon content rod should be used. We understand that "Sif-Tips" is to be published quarterly, and we wish the new enterprise every success.

The Poumay Cupola.

The compiler of Students' Corner dismissed the question of the Poumay cupola with a rather meagre description, considering the position it has attained in British foundry practice. Our attention having been called to this, we publish a description emanating from the engineer in charge of its sale in Great Britain. This furnace, by the way is handled by Messrs. Thomas E. Gray & Company, Limited, 119, High Holborn, London, W.C.1.

How the Poumay System Works.

The Poumay process, which is patented, is based upon the reasoned study of the chemical reactions taking place in a cupola when the latter is in operation. Its adoption results in a reduction of from 30 per cent. to 50 per cent. of the fusion coke, also in a reduction of the oxidation which takes place in the vast majority of present-day cupolas. The economy in coke is effected by obtaining a practically perfect combustion, all the useful gases being burned in the cupola below the level of the charging door—while the oxidation is reduced by using the minimum quantity of air necessary for complete combustion and by reducing the quantity of air passing through the lower or fusion tuyeres.

Under present-day practice it is aimed to produce CO_2 under the fusion zone, and to ensure this, air in excess of the amount actually required is utilised. Air in excess will naturally increase the percentage of CO_2 which it is aimed to obtain, but it should be borne in mind that it is not possible to prevent the reaction $CO_2 + C = 2\ CO$ and $CO_2 = CO + O$ from taking place when CO_2 passes through the incandescent coke, and it is because of this that in practically every case to-day the gases escaping from a cupola contain as an average equal weights of CO and CO_2, with the result that the fuel will yield up only approximately 9,500 B.T.U. per lb. of carbon burned. Instead of aiming at the production of CO_2 under the fusion zone, the Poumay process aims at the production of CO and the fusion and preparation tuyeres are designed expressly to achieve this result.

Having in veiw the fact that 1 lb. of carbon burned to CO_2 evolves 14,500 B.T.U., and 1 lb. of carbon burned to CO evolves only 4,350 B.T.U. it would at first sight seem to be a paradox to aim at the production of CO under the fusion zone, as from the figures given above it will be appreciated that the presence of CO indicates incomplete combustion. With the Poumay system, however, there are two stages of combustion. Firstly, the carbon is transformed to CO under the fusion zone. Secondly, the combustion of this gas in the charge. The result is achieved by the use of a series of auxiliary tuyeres placed at varying heights above the wind belt.

Numerous analyses which have been carried out by reputable firms have shown the complete absence of CO at the charging-door level, proving that the fuel is completely burned, yielding up its full calorific value, *i.e.*, 14,500 B.T.U. per lb. of carbon. This explains why such large economies in coke can be effected under this system.

The working of the process is easily explained. The whole of the CO formed under the fusion zone is burned at different levels in the charges, the ascending gas becomes poorer in CO and correspondingly richer in CO_2. The descending charges receive progressively the B.T.U. emitted by the exothermic reaction of CO burning to CO_2, and the nearer the charges come to the melting zone the hotter they become, with the result that upon reaching the fusion zone they fuse very rapidly.

Selenium in Canada.—According to the "Canadian Mining Journal," Canada is now in a position to produce selenium in large quantities. It is obtained as a by-product in copper refining, and was produced for the first time in Canada early in 1931.

Random Shots.

Last week, "Marksman" was nosing around the Cotswold Hills, looking at churches and derelict flour mills, and he strongly recommends the various corrosion committees also to nose around. There are dated specimens of cast iron in the form of gravestones, and authentic ages of gearing for gyrating grindstones which bear excellent testimony to the work of that alloy as a rust-resistor. One gravestone dated 1868 still has letters as sharp and clear as the day it left the fettling shop, whereas contemporary ones in stone are virtually illegible.

* * *

During his tour "Marksman" had to despatch a few telegrams—just to show how important he is. The telegraphic address that worried his memory the most was his own—"Zacatecas." We started wondering why such a name was ever chosen. Of course, being good at geography, "Marksman" knows that Zacatecas is a town in Mexico—but why did some director of twenty or thirty years ago choose such an outlandish word? We can only think he had been having a flutter in Mexican Eagles and thought it might bring him good luck. Now the very best telegraphic address in the metallurgical world is "Forward, Sheffield," as it tells the truth—it is—if you send one for Ward (T. W. of that ilk). One other Sheffield address sticks in the memory as giving a quite unnecessary reminder to the servants of His Majesty's Postmaster-General—*Urgent*. Other firms give themselves a pat on the back, like Adaptable, Birmingham; Alive, Newport; Amicable, Birmingham, whilst others cast aspersion upon their locality, like "Chuck Leicester," or "Scrap Sheffield," or "Chinese Glasgow" and "Smellie Dudley." Some establishments have tried to impress correspondents by the "shock" method. Fancy receiving a telegram reading "You have drawn April 1 in the Irish Sweepstake Collapse," or "Advise buy Unilevers Coalwasher." Thus, all telegraphic addresses are not suitable for all occasions. For instance, what would one think if one received a wire from Sheffield reading "Was involved in serious motor accident this morning—cannot keep appointment—Handcut." "Marksman" confesses that all these addresses were not stored up in his brain-box—they have been filched from the list in Ryland's Directory. The most grandiose appearing in this list is "Mobilising London," whilst dozens indicate what they manufacture, like "Knife," "Lathe," "Leather," "Nuts," "Screws," "Oilcan," "Padlock" and "Pick-axe." Still, after a perusal of this formidable list, we still award the pride of place to T. W. Ward for "Forward" and the booby prize to ourselves for "Zacatecas."

* * *

Those foundrymen whose book reading never takes them beyond the title pages will appreciate the following collection which "Marksman" presents for their edification:—

Cutting it Fine, by Moses Lawn.
Pussyfoot's Triumph, by Bruno Moore.
The Corn, by Honor Foote.
Expelled from School, by Millicent Holme.
The Sovereign, by Iona Dudden.
The Antiques, by Fay Kingham.
The Bus Conductor, by Miles Standing.
The Cliff Tragedy, by Eileen Dover.
Twopence All the Way, by Elsie C. Carr.
Knighted, by Watts E. Dunn.
The Mother-in-Law, by George Orr.
Wine and Women, by Rex Holmes.
Stand and Deliver, by Ann Dover.
The Woman Who Sang, by Topsy Sharpe.
The Housing Problem, by Rufus Quick.
The Song of the Shirt, by Dryden Aird.
The Soldier's Plate, by Lydia Mestyn.
Gossip, by Liza Bound.
His Sin, by Harriet Onions.

Marksman.

Contraction, Distortion and Camber in Grey Iron Castings.

By E. Longden.

(*Concluded from page* 408, *vol.* 46.)

A Large Lathe Casting.

Fig. 14 illustrates a 50-in. centre lathe—a typical heavy machine tool. The bed is 80 ft. in length and approximately 70 tons total weight made up of three castings, the longest section being 30 ft. and 26½ tons in weight, and illustrated in Fig. 3. Fig. 4 discloses the strong girder-like construction of the bedplate, which suggests little need for camber allowance. But the design in this case is not too helpful to the foundry. The metal in the shears, S, cools very slowly, due to mass and location in the mould, with the consequent excessive growth of graphite. The precipitation of graphite and slow cooling of the heavy section indicated causes it to expand at a period when the general and thinner sections are contracting, which results in distortion. The 30-ft. bedplate mould is set down in the centre, *id est*—cambered—$\frac{7}{8}$ in., which produces a straight casting when cold. The mould is poured through each of the four shears from both ends.

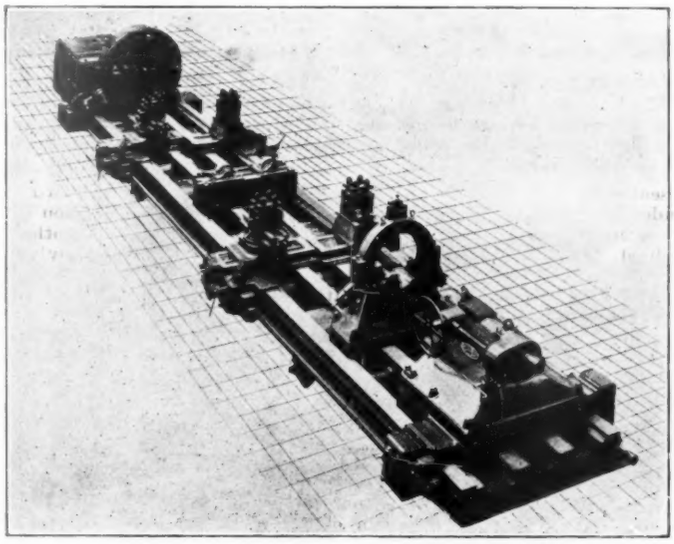


FIG. 14.

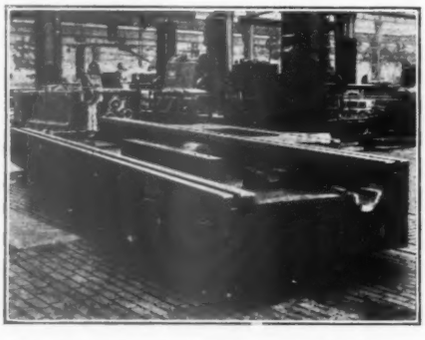


FIG. 15 SHOWS A BED-PLATE CASTING FOR A 7-FT. RAILWAY WHEEL-TURNING LATHE.

A Bed-Plate and other Large Castings.

Fig. 15 shows a 13-ton bedplate casting for a 7-ft. railway wheel turning lathe, and Fig. 16 a sectional sketch of the casting. In design the casting will be strong, but the massive metal around the tee slots creates, again, a similar set of conditions, as previously outlined for the bedplate of the 12 ft. 6 in. planer-machine, except that the bearings on the plated section tend to retard their cooling, thereby approaching a little more nearly the cooling rate of the massive metal around the tee slots. Half-inch downward camber in the centre is allowed on this 21 ft. casting. The mould is poured from each end, through in-gates situated on both sides of the tee-head slot cores.

Fig. 17 shows a bedplate casting for a 26 in. centre-lathe weighing 13½ tons. It will be noted that, excluding the extra width of the headstock end, the casting is only 4 ft. 6 in. in width, although 30 ft. 6 in. in length. The narrow section of the bed compared with the depth, along with the plated sections U, reduces the general deformation and need for camber. An allowance of only $\frac{5}{8}$ downward setting in the centre is needed. The metal is admitted to the mould from both ends through the shear section.

Fig. 18 illustrates an axle returning and burnishing lathe. The bedplate casting is approximately 14 ft. long and 7 tons in weight.

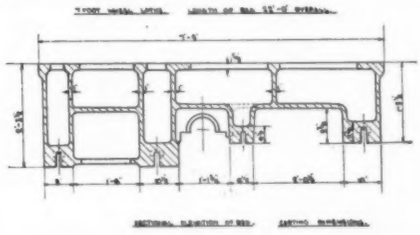


FIG. 16.—SECTION THROUGH THE CASTING SHOWN IN FIG. 15.

The general section is shown in the two sketches of Fig. 19. The camber in this case is the reverse of the previous examples described, and, instead of the centre, the ends are set down, although only ⅛ in. This reversal of the camber is the outcome of the breaking up of the continuity of the heavy shears by the gaps in the bed casting and, also, the comparatively greater depth and narrowness of the design. The casting is poured again from each end of the mould through the shears, but auxiliary gates are arranged to pass through the sand, forming the gaps between the shears. Figs. 20 and 21 show the 3½-ton bedplate casting for a tyre borer. Contraction across the diameter at points V is less than standard, being only $\frac{5}{8}$ in., but across the casting at right angles to points V, the contraction is only ½ in. Thus the casting is

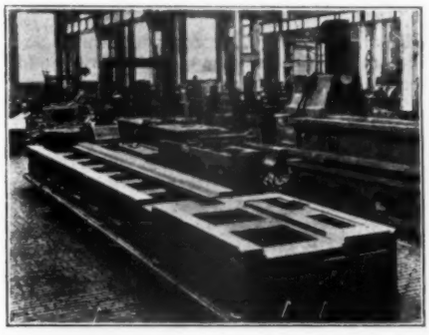


FIG. 17 SHOWS A BED-PLATE CASTING FOR A 26-IN. CENTRE LATHE WEIGHING 13½ TONS.

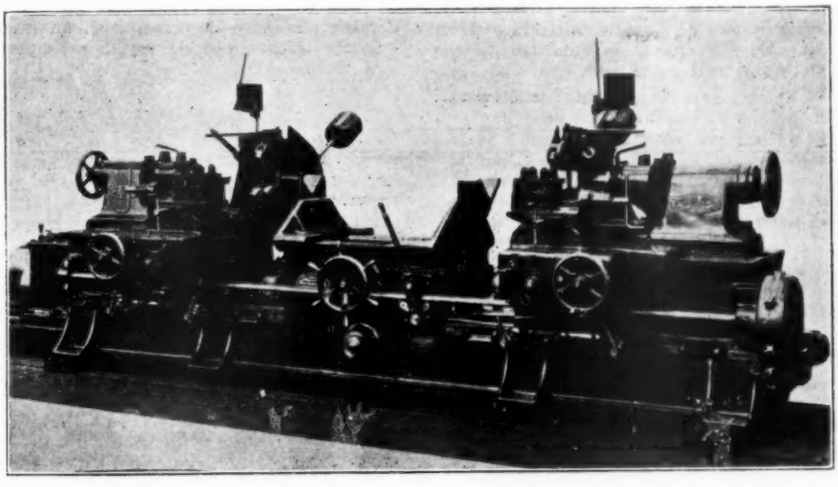


FIG. 18 SHOWS AN AXLE-RETURNING AND BURNISHING LATHE.

slightly eliptical, which can be ascribed to the contraction and pull of the trough-section, which is shown in the left hand of Fig. 21. The right hand sketch shows a fuller cross-sectional view of the casting.

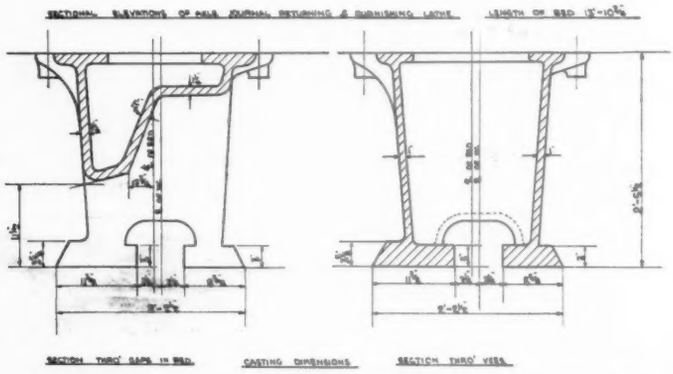


FIG. 19.—SECTIONS THROUGH THE BED-PLATE CASTING OF FIG. 18.

The low contraction and slight deformation is the outcome of the resistance of a compact body of cores and the introduction of special denseners on the heavy section cast in the bottom of the mould. The mould is filled with metal through specially arranged in-gate cores, which run under the denseners to the centre of the mould. Further auxiliary runner-gates are arranged about midway up the side of the mould.

Fig. 22 shows a grinding machine with a narrow deep bedplate 28 ft. in length and

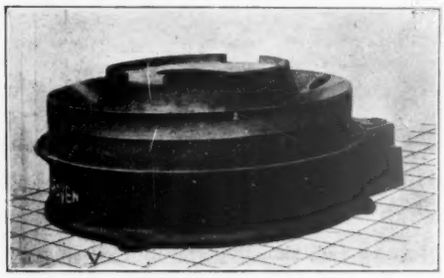


FIG. 20 SHOWS A TYRE-BORER CASTING.

weighing 8 tons. In this case only a $\frac{1}{4}$ in. of downward camber in the centre is necessary. The casting is moulded the working face down in the mould. The metal is admitted to the mould in the V-sections at each end.

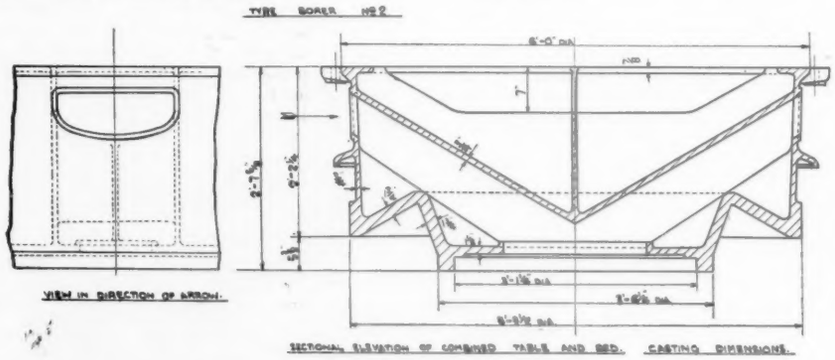


FIG. 21.—SECTION THROUGH THE CASTING ILLUSTRATED IN FIG. 20.

Generalisations on Camber.

Sufficient examples have now been given to provide the following general rules:—

Camber allowance, other dimensions remaining constant, increases with an increase in length of a casting.

Camber allowance increases with a reduction in metal section.

Camber allowance must be decreased as the depth of the casting increases, without any corresponding increase in length.

Camber allowance slightly decreases with a reduction in width.

Camber allowance would have to be increased slightly with an increase in the plated area in the bottom of the mould.

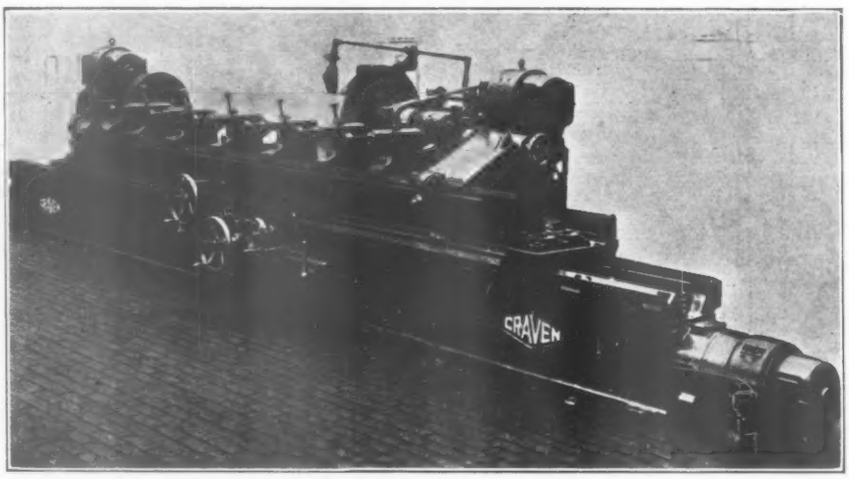


FIG. 22 SHOWS A GRINDING MACHINE WITH A 28-FT. BED-PLATE WEIGHING 8 TONS.

Camber allowance decreases with an increase in the thickness of the metal in the bottom of the mould.

Camber decreases with an increase in the plated area in the top side of the mould, as against a casting made in the same way with a lesser plated area.

If, in the various examples shown, the castings had been box-shaped, that is plated sides and bottom and open at the top, and all sections equal—say 1 in.—quite double the camber outlined would be needed. Actually it would be almost impossible to produce a casting without fracture of an area similar to the bedplate shown in Fig. 3 and of 1-in. plated section throughout.

The camber chart, Fig. 1, and the foregoing will indicate the basis of camber allowances in medium and large castings, although care must be exercised in deciding on the camber since other variables in design may modify the rules. In the castings outlined temperature and quality of metal variation will not influence camber to any great degree.

It is important that no mistake be made by the moulders when setting the camber strips for the bed of the mould. Errors may occur due to crosswinding and excess camber consequent on the sagging of the string which is used to set the camber strips. Greater accuracy is obtained when using wire for the latter purpose. It is important that all camber instructions be checked finally by a charge hand or foreman.

Shrinkage or Contraction Tests in Grey Iron.

The following notes may help a little to understand the cooling changes in grey cast iron and their effects on deformation, and can be considered as supplementary to the work of Heggie in 1914 and the more recent study by Servais in his French Exchange Paper of 1928. Mr. Servais' study originated from a difference of opinion between Mr. Goujon, the French metallurgist, and Mr. Ronceray. In a book written by Mr. Goujon on the subject of shrinkage, the author seemed seriously concerned with the anomalies which he discovered in special test-castings carrying thin and thick sectioned bars, shown in at *c*, Fig. 24. His conclusions were that, contrary to accepted opinion, thin sections have less shrinkage than thicker sections.

Servais asserts that Goujon ascribed the anomalies to the assumed fact that the rate of cooling of the thin parts is in inverse ratio to the thickness: the whole or part of their shrinkage takes place while the larger thicknesses are still liquid, and are capable of feeding the thin parts with sufficient metal to maintain equality in length throughout the system. Ronceray in disagreeing with Goujon states:—

"I do not think that Goujon is correct; the shrinkage in length, in fact, does not begin to operate until after solidification, and it is, therefore, impossible to conceive of the thin parts being fed by the thick parts during shrinkage in the solid state. At the most, the liquid shrinkage might be compensated. We must, therefore, look elsewhere, and the most reasonable hypothesis appears to me the following:—

"The metal when heated must possess—con-

trary to what occurs when it is cold—a certain property of elongation or of contraction; the solidified thin-parts are the first to exercise a tensile stress on the ends of the frames. As

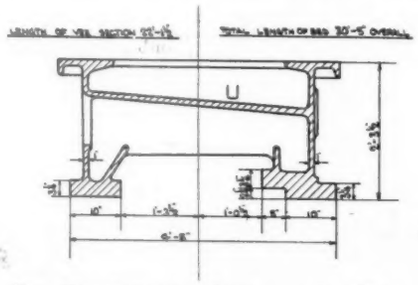


FIG. 23.—SECTIONAL ELEVATION OF A 26-IN. CENTRE LATHE BED CASTING.

soon as they have become sufficiently solid, the ends are firm, and they act through the frame on the thick parts, causing them to shrink; the latter, being still pasty, yield to this stress, whilst at the same time the thin parts cool and become firm, the shrinkage of the thick parts then takes place, but it is opposed by the thin parts already cooled. The shrinkage thus creates internal tensions and cause fractures."

Servais encountered similar anomalies, as did Goujon, and after careful tests came to the conclusion that the explanations given by Ronceray were correct, and that thin sections did contract to a greater extent than thick sections, as is generally understood. The present author cannot understand why simply comparative check tests were not taken in parallel at the same time. Similar sections of metal cast separately should have been tested at the same time.

The following experiments, whilst having no claim to be ultra-scientific, are simple and confirm the conclusions of Ronceray and Servais. Sketch *d* and *e*, Fig. 24, describes the test castings used in the experiments. Test-casting *d*, it will be noted, carries a series of bars $\frac{1}{4}$ in. × 1 in. up to 1 in. square, strung together by end sections, thus forming a grid-like frame. Similar sections of metal, shown at *e*, were cast separately. Test-castings were poured in green-sand moulds from the same metal, the analysis being:—T.C., 3.3; Si, 2.0; Mn, 0.65; P, 0.85, and S, 0.12 per cent. The casting-temperature was approximately 1,350 deg. C.

The separately-cast bars contracted as follows:—1 in. sq.—$\frac{15}{64}$ in.; 1 in. × $\frac{3}{4}$ in.—$\frac{1}{4}$ in.; 1 in. × $\frac{1}{2}$ in.—$\frac{1}{4}$ in. full, and 1 in. × $\frac{1}{4}$ in.—$\frac{15}{64}$ in.

The multiple bar casting is shown in Fig. 25. A tap with a hammer easily fractured the sections connecting up the bars. The comparative lengths may be distinguished in the illustration. The $\frac{1}{4}$ in. bar is $\frac{3}{64}$ in. longer than the $\frac{1}{2}$ in. bar. The $\frac{1}{2}$ in. bar is $\frac{1}{32}$ in. longer than the $\frac{3}{4}$ in. bar and the last $\frac{1}{100}$ in. longer than the in. square section.

Before fracture, the casting showed the thin section to be cambered, as described in the sketch *f*, Fig. 24, and the thicker bars slightly the reverse way. After fracture, the thin $\frac{1}{4}$ in. bar cambered the opposite way a little and lengthened. The thicker bars retained most of the original slight camber, so far as could be reasonably measured.

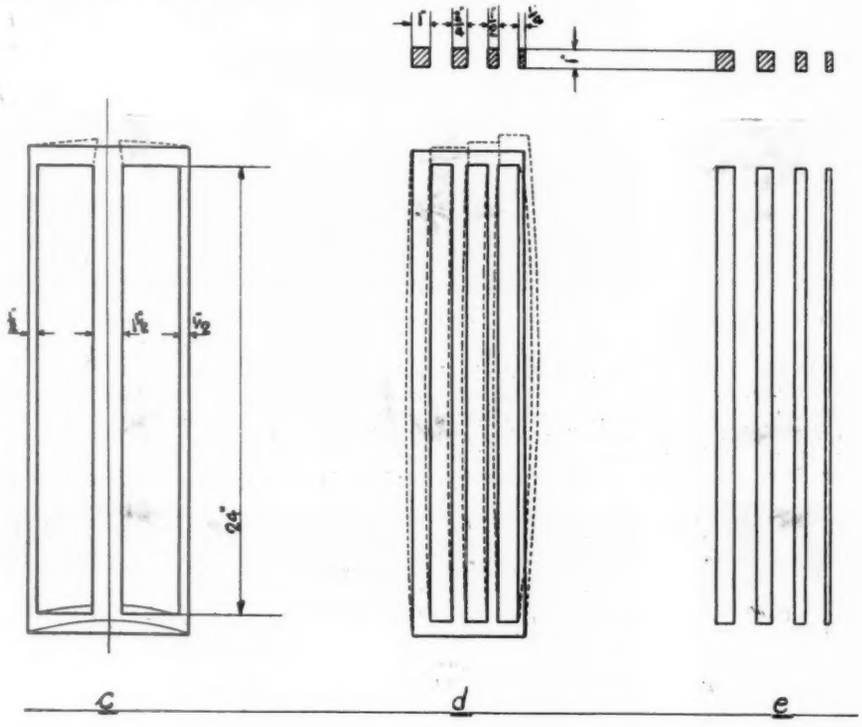


FIG. 24.—CAMBER EXPERIMENTS ON VARIOUS-SIZED BARS.

The length of the thin bar compared in length with the same-sectioned bar cast-separately; but the thicker bars showed a slight reduction in length compared with the thicker bars cast-separately and accounted for, mainly by the slight camber in the multiple cast bars. Whilst there was no evidence of elongation in the $\frac{1}{4}$ in. bar, the thick bars had clearly been compressed, probably during the pasty stage, causing a slight reduction in length by cambering the neighbouring thick bar on the adjacent side.

The sketches of Fig. 26 describe a further simple test. Two bars, $\frac{1}{4}$ in. × 4 in. × 4 ft. and 2 in. × 4 in. × 4 ft. were poured side by side from the same ladle of metal, the analysis being:—T.C., 3.25; C.C., 0.65; Si, 1.7; Mn, 0.6; P, 0.9, and S, 0.11 per cent. The ends of the bars were cast against machined chills. At one end "*a*" the chills were tightly butted against the moulding box side. At the other end "*b*" the chills were supported by solidly-rammed sand. The mould was made open green sand on edge and top-poured in the centre from a common pouring-bush. Table I details their behaviour.

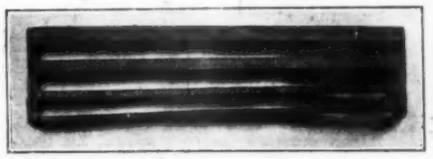


FIG. 25.—MULTIPLE BAR CASTING.

Only one expansion, of course, could be noted, but it was very obvious when the chills at the end "*b*" supported by sand only were seen to be thrust back for approximately $\frac{3}{64}$ths of an inch. The movement appeared to last for about 15 secs. with the thin bar and with the thick bar 20 secs. This movement was confirmed the following day on examining the cold casting. The gap between the ends of the bars and the chills at "*a*" were a $\frac{1}{4}$ in. with both bars, and at the end "*b*," which had been constructed to allow and to respond to any post-solidification expansion, the gaps were in the case of the thin bar $\frac{19}{64}$ in. and the thick bar $\frac{15}{64}$ in.

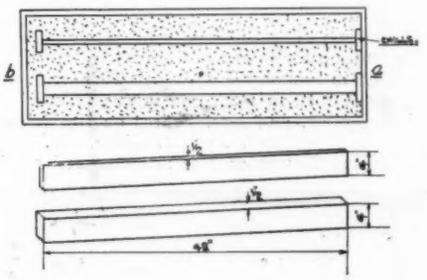


FIG. 26.—FURTHER TEST EXAMPLES.

It is quite evident that at a period, some time after solidification, that the casting is slightly larger than the mould. If the material composing a mould is strong enough to resist expansion and distension of the skin of the casting on cooling, or if the cooling of the outer envelope of the metal is accelerated so that a resisting wall of solidified metal is formed, then the energy released by the dissociation of carbon is returned

TABLE I.—*Expansion and Contraction of Experimental Bars.*

	$\frac{1}{4}$ in. by 4 in. by 4 ft.	2 in. by 4 in. by 4 ft.
Contraction after 15 minutes	$\frac{1}{4}$ inch	Nil
" " 25 "	$\frac{9}{32}$ "	$\frac{1}{32}$ inch
" " 35 "	$\frac{13}{32}$ "	$\frac{3}{64}$ "
" " 45 "	$\frac{7}{16}$ "	$\frac{3}{16}$ "
" at normal temperature	$\frac{23}{64}$ "	$\frac{21}{64}$ "
Expansion after 10 minutes	$\frac{1}{32}$ "	Nil
" " 20 "	Nil	$\frac{3}{64}$ "

(*Concluded on page* 12.)

Foundry Training at the Constantine Technical College, Middlesbrough.

By A. Groves.

Notable additions to the facilities for foundry training in this country to which we have not previously referred in detail, are the courses offered by the Constantine Technical College, Middlesbrough. Previous to the opening of the College by the Prince of Wales, Mr. Percy Fox-Allin wrote a series of articles entitled "British Facilities in Foundry Training." This series was actually started in 1928, and it was followed by articles by Mr. and Mrs. Pearce on the Schools at Paris, Düsseldorf, Aachen, Liége, etc. The Constantine College courses are now well established, and it seems desirable to include some details of this College and its work.

FIG. 1.—GENERAL METALLURGY LABORATORY, CONSTANTINE TECHNICAL COLLEGE.

FIG. 2.—FURNACE AND ASSAYING ROOM, CONSTANTINE TECHNICAL COLLEGE.

Most worthy of note is the provision of a two-year full-time course in foundry technology. This is open to students of 16 years or over of good general education, and includes the necessary fundamental subjects as well as foundry technology; experimental foundry work; pattern-making; engineering drawing; mechanical testing; physical metallurgy, and metallurgical analysis.

The course throughout is essentially a practical one directed specifically to the foundry industry and much of the teaching is given by a full-time foundry instructor. An integral part of the course is a visit during the summer vacation to an industrial foundry for six to eight weeks. In the summer of 1931 through the kind offices of Mr. J. A. Smeeton, students spent this time in the works of Messrs. Heinrich Lanz, A.-G., Mannheim. In connection with the course is an Advisory Committee comprising members from the Institute of British Foundrymen, Iron and Steel Institute, Institute of Metals, and British Cast Iron Research Association, and it is hoped that the diplomas awarded by the College at the end of the course will be endorsed by these bodies. Part-time evening courses leading to the recently established examinations in foundry practice and in pattern-making of the City and Guilds of London Institute are also held.

The equipment of the College for the teaching of foundry technology and metallurgical subjects is of the most up-to-date character. In the experimental foundry is a Titan Cupolette melting 10 cwts. per hr.; a large experimental gas-fired furnace by Wincott; Pneulec core oven, sand mill, moulding pit, a core bench and a full complement of the necessary small equipment. Non-ferrous melting is done in the furnace room either in coke furnaces or injector furnaces. In the heavy metallurgy laboratory is an Ajax-Northrup high-frequency furnace

A block of rooms is devoted to physical metallurgy including photomicroscopy, with instruments by Reichert and Watson; heat-treatment, and mechanical testing. Testing machines of all chief types are also provided in the materials testing laboratory, and adequate provision is made for analytical work. Great care is taken, especially in the second-year full-time course, to correlate all the subjects in the course, so that students in their experimental work can follow through the whole sequence of operations, including the making of drawings, patterns and moulds, melting and casting of metal, analysis, micro-examination and mechanical testing of the product.

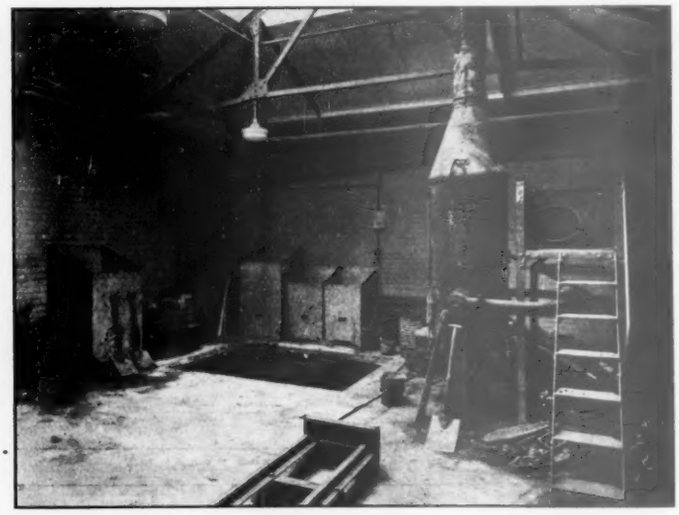


FIG. 3.—FOUNDRY CUPOLETTE AND MOULDING PIT, CONSTANTINE TECHNICAL COLLEGE.

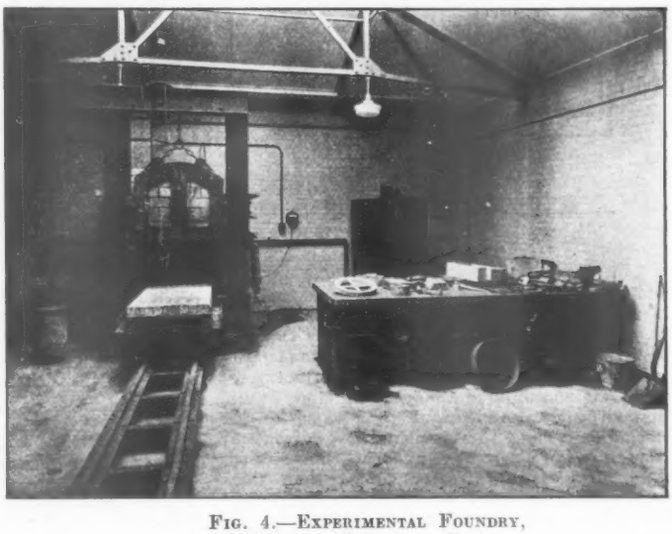


FIG. 4.—EXPERIMENTAL FOUNDRY, CONSTANTINE TECHNICAL COLLEGE.

It is widely realised that instruction in foundry work has to a considerable extent lagged behind that in other branches of metallurgical and engineering practice, and it is felt that the courses offered by the Constantine College are a real step in the right direction.

Introduction to the Study of Moulding and Casting.

By J. Pillon.

(FRENCH EXCHANGE PAPER.)

(*Continued from page* 404, *vol.* 46.)

Now, examining a curved surface, the pressures are no longer parallel to each other, and as a general rule they reduce to a force and a couple (Fig. 104). It is still the same for the cylinders with a base ds, the weight of which is always $h.ds.\delta$, having three components along

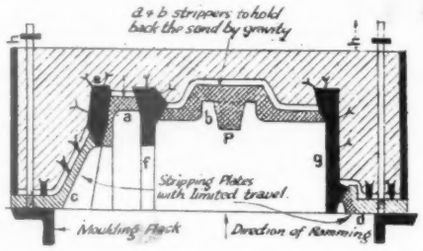

a + b strippers to hold back the sand by gravity
Stripping Plates with limited travel
Moulding Flask
Direction of Ramming

FIG. 75.

the axes, the vertical component being $h.\delta.ds.\cos\alpha$. However, $ds.\cos\alpha$ is ds^1, the projection of ds on the loading plane. All the elements ds together give a total

$$\Sigma\, h.\delta.ds.\cos\alpha.$$

And since $ds.\cos\alpha$ is ds^1 the projection of ds on the loading plane, one can deduce the identical

FIG. 76.—COMPLEMENTARY BOX.

conclusion as formerly, *i.e.*, the curved surface S is subjected on each side to a vertical component measured by the weight of a cylinder of metal, the base of which is S^1, the projection of S on the loading plane, of which the sides are the lines of projection and which is cut off by the imaginary curved surface. The point of application on a horizontal plane is the projection of the centre of gravity.

Closed Curved Surface.

This surface can be either the interior of a mould or an entirely free solid body. Let P

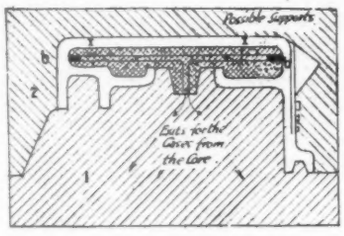


FIG. 77.—MOULDING FINISHED.

be the loading plane or free surface, and taking the cylinder projected vertically from the parting X which divides the surface into two zones, the upper one the cope, the other lower one the drag and applying the above conclusions.

The cope of the mould receives upwards a vertical force which constitutes the lifting force, the value of which is equal to the weight of a truncated cylinder having as base the projection of the parting on the free surface, generated by the projecting lines and cut off by the surface of the cope (Fig. 105). The drag receives downwards a vertical component which tends to break it up, the value of which is equal to the weight of a truncated cylinder similar to the previous one, but cut off by the surface of the drag (Fig. 106).

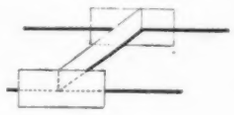


FIG. 78.

The resultant of this lifting force and downward thrust, is a vertical force passing through the centre of gravity of the mould, the value of which is obviously the weight of metal cast (the difference between the hatched areas).

Here is encountered the Principle of Archimedes which is one result of Pascal's Law, much more

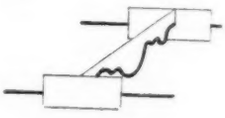


FIG. 79.

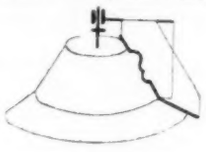


FIG. 80.

general and discovered 18 centuries later. It may be noted that the height of the loading plane (free surface) has nothing to do with the difference between the lifting force and downward thrust, but that the surface of the mould is more and more distended the greater the

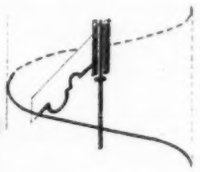
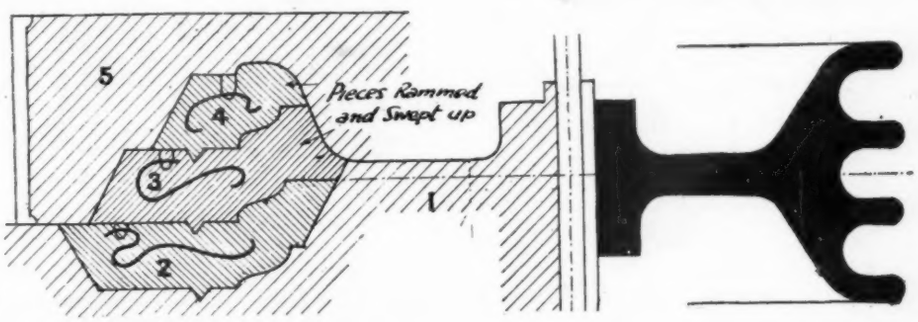


FIG. 81.

FIG. 82.

height of the free surface, and for the same reason the walls of the cores are more and more compressed.



FIGS. 87A (RIGHT) AND 88 (LEFT).

Summary of the Preceding Conclusions.

No hypotheses has been made regarding the more or less complicated surfaces of the mould; whatever these surfaces may be, the reasoning leads to the same results. The cores and projections are, therefore, to be definitely included in the calculations of the weights of the cylinders of lifting force and downward thrust (Figs. 107 to 112). It may be observed, in passing, that defective contact at the joint may have considerable effect, the parting then becoming the

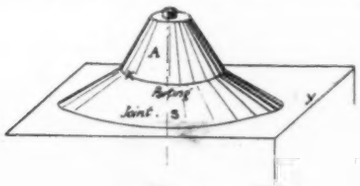
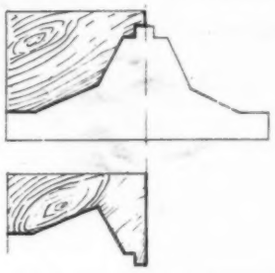


FIG. 83.

periphery of the fin and a few grammes of metal passing into the joint can increase these lifting forces and downward thrusts by several hundreds of pounds (Fig. 113).

In conclusion it may be added that it is essential to place weights centrally with the resultant lifting force, otherwise the two equal



FIGS. 84 (UPPER) AND 85 (LOWER).

forces not in line give rise to a lifting couple tending to rotate the cope around the side most under the influence of the weights (Fig 114).

The Practical Estimation of the Forces.

The calculation of the volumes and weights of the cylinders of forces is easy when the shapes

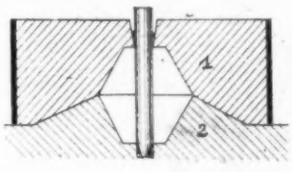


FIG. 86.

FIG. 87.

are geometrical, as, for instance, in a pan mould (Fig. 115). It can thus be found very easily that, for this casting weighing 5¼ tons, the force tending to lift the cope is 46·04 tons, and the pressure on the drag is 51·47 tons. These forces act along the vertical axis. The

lifting force on the rope could be balanced by an axial load of 46 tons, including the weight of the inverted dome which forms the cope, or also by six anchor bolts distributed equally, and

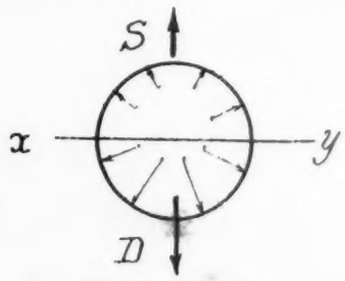


Fig. 101.

each taking a pull of about 7.75 tons. But in the most usual case, the volumes are irregular, and the calculation of the weights of the cylinders of forces S and D is complicated. A

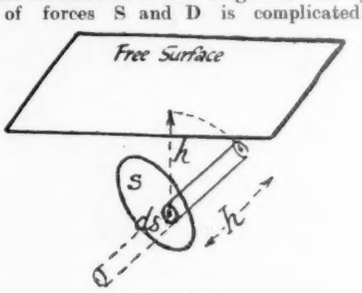


Fig. 102.

number of methods can be employed to get over the difficulty. In the first place, using the methods of solid geometry, they can be split up

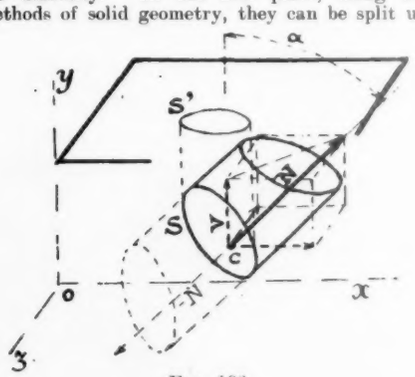


Fig. 103.

into elements of volume approximately geometrical, and then combining the individual weights by the classical methods of finding the resultant

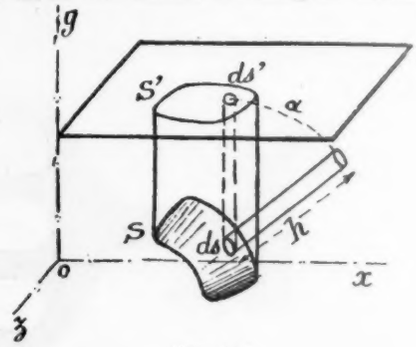


Fig. 104.

of parallel forces acting in the same direction. The total resultant force and its point of application is thus determined (Fig. 114).

It is also possible to make a model on a reduced scale, in clay, wood, plaster of paris, wax, etc., of the volumes to be estimated, and immerse this model in a graduated vessel containing water. This gives immediately the volume of the model, and consequently the volume sought, since the two volumes are proportional to the cubes of their linear dimensions; thus, if the scale of the model is one-tenth full size, the volume sought is a thousand times that of the water displaced.

With regard to the position of the centre of pressure on the plane of the cope, this can easily be determined experimentally, by balancing the model in question on its flat base on a straight knife edge in two directions, approximately at right-angles. The intersection of the lines of contact of the knife edge is the centre of pressure (Fig. 117). Such methods are only justified in the case of important moulds.

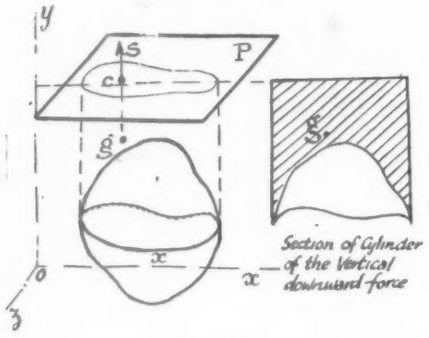


Fig. 105.

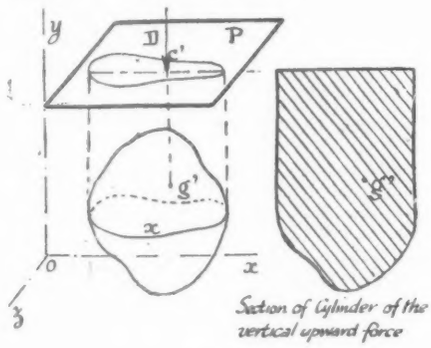


Fig. 106.

Various Examples.

Cylinder cover (Fig. 118): The axial core is subjected to a downward load by a vertical force of 2.8 tons along its axis, represented by the weight of a hollow cylinder, the base of

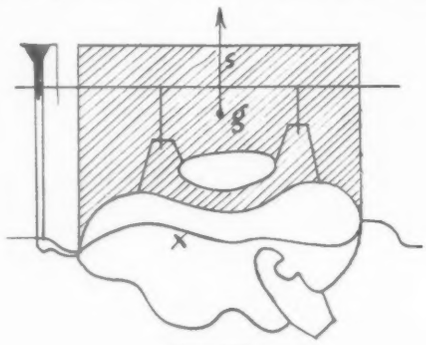


Fig. 107.

which is the annular shoulder *e* and the height is the distance from this shoulder to the free surface. The axial-lifting force on the cope is 144 lbs. (equal to the hatched volume less the four webs *a*, multiplied by the specific gravity of cast iron).

Half-Casing of a Hydraulic Turbine.—Fig. 119 shows the arrangement for moulding the left half-casing, weighing 2.8 tons. The lifting force on the cope acts at the centre of pressure C, the value being the weight of the cylinder on the base hatched B and of the core underneath, amounting to 70 tons.

All that has been previously said applies, as was stated at the beginning, to a casting when pouring is finished, but it is often useful to analyse the static phenomena during their development. For example, visualising the moulding of the casting shown in Fig. 121. The core, which belongs to the drag, is a solid body, for

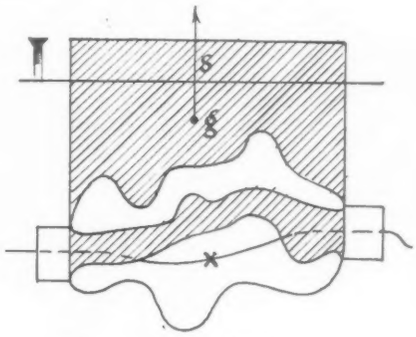


Fig. 108.

which the upward force is the difference between the truncated cylinders, defined as in Figs. 105 and 106.

However, the built-in end is not subjected to pressure (Fig. 120), the cylinder of the lifting force is reduced to the tubular volume shown hatched (Fig. 121). It is possible to follow with

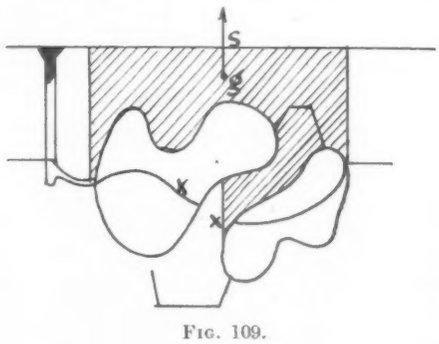


Fig. 109.

this drawing the changes in the effects of casting by using the different levels, *m*, *n*, taken in succession by the metal. In the same way the successive values of the lifting force and downward thrust on the parts of the mould can be analysed (Figs. 123 and 124).

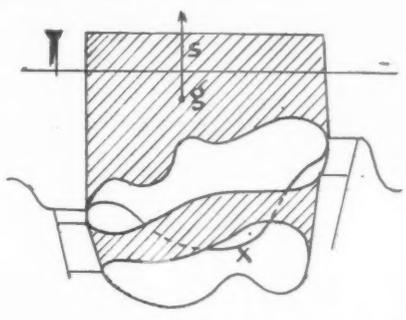


Fig. 110.

The Individual Forces Acting on Cores and Projections.

Projecting parts and cores which are detachable projections, cannot receive the same pressures as totally immersed solid bodies, and, there-

fore, the Principle of Archimedes can only be applied to them as a means of revealing by difference the force and the couple to which they are subjected. Considering a totally-immersed free body having on its surface a flat portion xy. On this flat surface of area Ω it receives pressures b which are parallel to each other, and on all the rest of the surface pressures a which

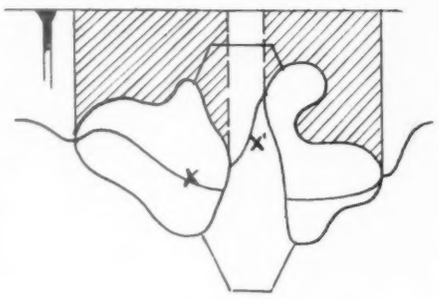


FIG. 111.

are not parallel. According to Archimedes' Principle

$$\Sigma a + \Sigma b = p$$

from which $\Sigma a = p - \Sigma b$

It is easy to determine the values and points of application of p and Σb by the methods previously described, p is the weight of the metal

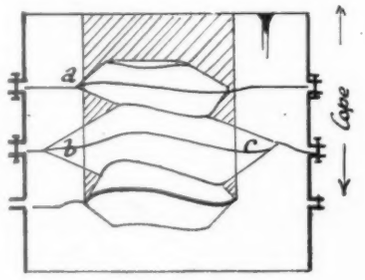


FIG. 112.

displaced by the immersed body, acting at the centre of gravity G of the body in question—Σb is the weight R of the truncated cylinder with base Ω and conic section Ω^1. This force $-R$ acts at the centre of gravity G of the cylinder thus visualised.

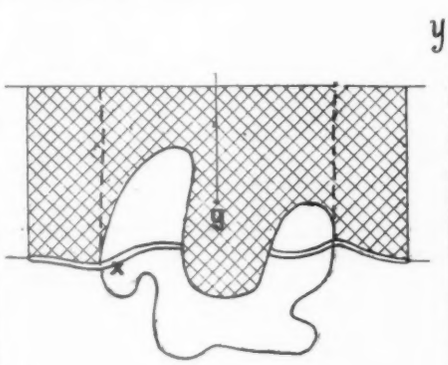


FIG. 113.

If, owing to symmetry, the vectors p and $-R$ are in the same plane, they intersect in the point k and the resultant ρ is directly found, this representing the force Σa carried by a core in which the section Ω, defined by the plane xy is the base of the print π (Fig. 126). If, on the contrary, p and $-R$ do not intersect, as is usually the case, the core is subjected to a force and a couple, the vectors of which are easily found by a very simple solid-geometrical diagram (Fig. 127). The resultant force ρ causes a component p at a distance d from $-R$. The couple is pd, which has to be balanced by a reinforcement which prevents the core turning in its point.

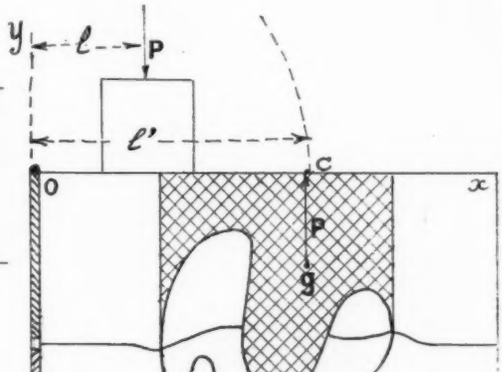


FIG. 114.

It can, therefore, be said that: To determine the force and the couple caused by the pressures acting on a core or on a projection, it is sufficient to deduct geometrically from the weight p of the metal displaced, the reaction caused by these pressures on the section where the core or other part is fixed, this being assumed to be plane.

Horizontal Forces—Necessity for Flasks.

Considering a ring ab of the interior surface of a mould, cut by horizontal planes infinitely

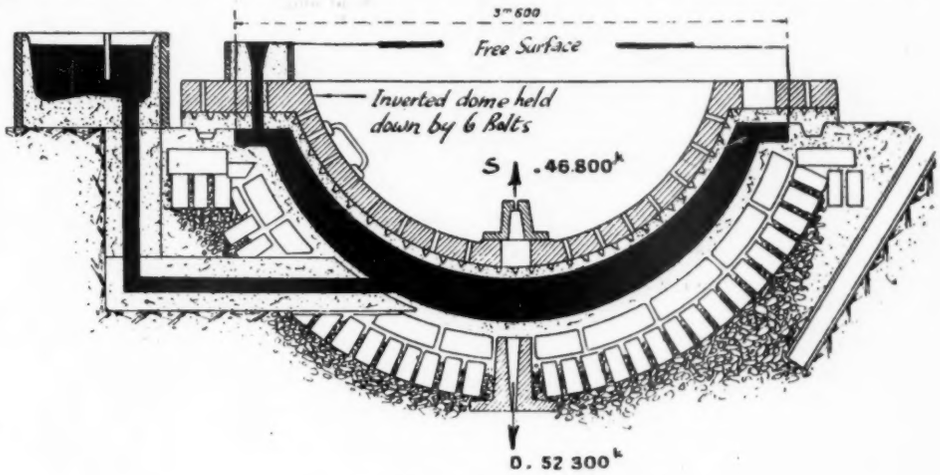


FIG. 115.—PAN CASTING WEIGHING 5½ TONS.

close together (Fig. 128). Each element of this ring receives the normal hydrostatic force N, previously defined, *i.e.*: $N = ds.h.\delta$, a force which can be decomposed into three components, one

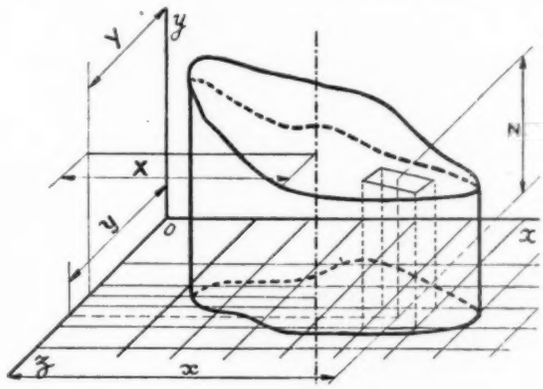


FIG. 116.

vertical $V = N \cos \alpha$, the effects of which have been dealt with lifting the cope and the crushing the drag, and two other components which are horizontal and parallel to ox and oz respectively. Visualising that parallel to ox, the value of it is $H_x = N \cos \beta - ds.h.\delta \cos \beta$.

However, $ds. \cos \beta$ is ds', the projection of ds

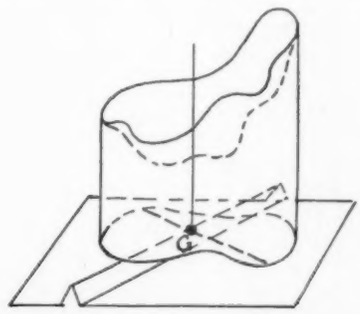


FIG. 117.

on the right-hand lateral plane parallel to yoz. It is to be noted that $ds.h.\delta$ is the weight of an elementary prism of metal which, as indicated by the diagram, is exactly balanced by that

which, in its extension to the left, has the base ds. The whole of the surfaces ds and ds'

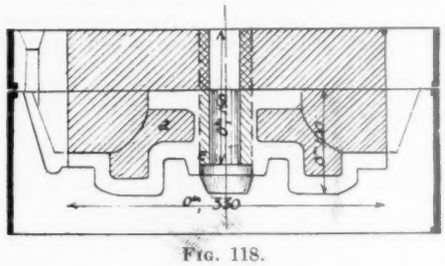


FIG. 118.

form two curvilinear trapeziums, projections of the elementary ring between a and b, and the horizontal forces on these trapeziums are

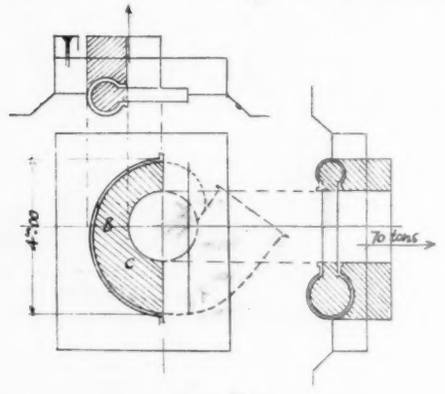
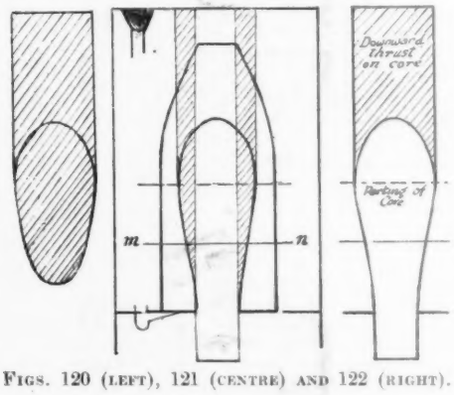


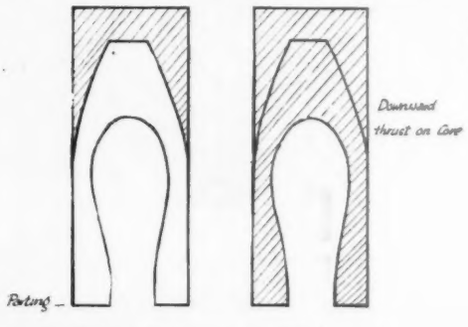
FIG. 119.

measured by the weight of the prisms, having for bases the trapeziums considered, and height equal to the distance to the free surface.



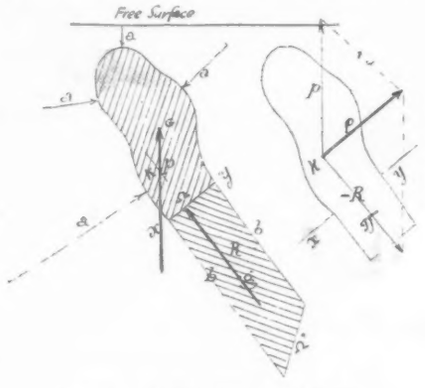
FIGS. 120 (LEFT), 121 (CENTRE) AND 122 (RIGHT).

Applying the same reasoning to the whole, one is led to conclude that: The thrust is measured on both sides by the weight of a cylinder of



FIGS. 123 (LEFT) AND 124 (RIGHT).

metal the base of which is the projection of the outline on the vertical planes P′ and P″, the boundaries being the projecting lines cut off by a plane at 45 deg. The centres of pressure C are



FIGS. 125 (LEFT) AND 126 (RIGHT).

the projections of the centre of gravity G on P′ and P″. If the planes P′ and P″ represent

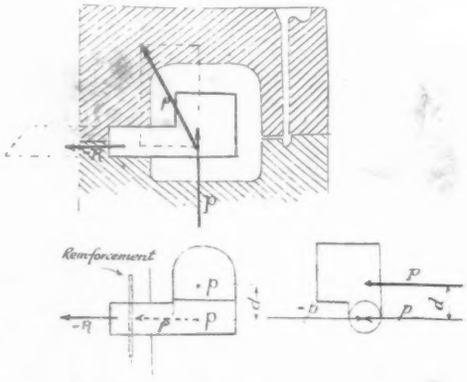


FIG. 127.

two opposite sides of the box, it will be seen that the forces and their points of application

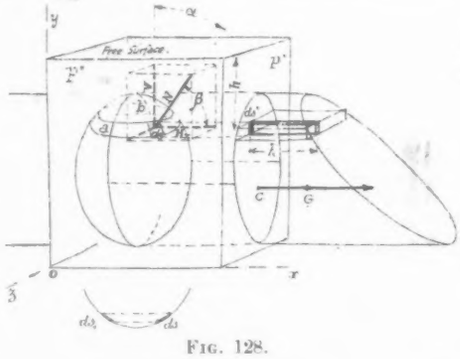


FIG. 128.

can be perfectly determined, as also for the other two sides, and that it is possible to check or calculate the thickness of the box.

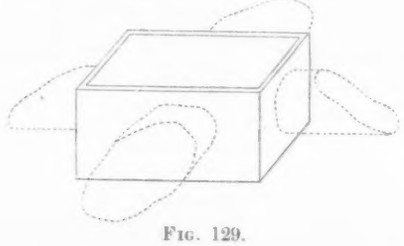
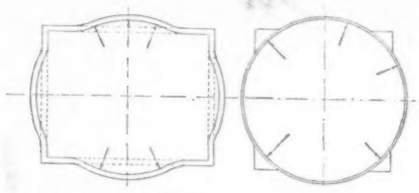


FIG. 129.

It may be noted that the rectangular shape does not satisfy the fundamental hypotheses of the strength of materials, since the corners form, on the mean fibre, individual points for which the radius of curvature is very small compared with the dimensions of the straight section (Figs. 130 and 131). Each side should therefore be visualised as a solid fixed at the ends, subjected to bending and tending to deform under



FIGS. 130 (LEFT) AND 131 (RIGHT).

stress and approach the circular section, for which the thickness required would be a minimum. The circular box is therefore, in principle, preferable to the rectangular box; from this point of view, it is like a boiler in which the pressure varies from top to bottom. It is not subjected to bending, but only to extensional forces which, in each horizontal plane, are

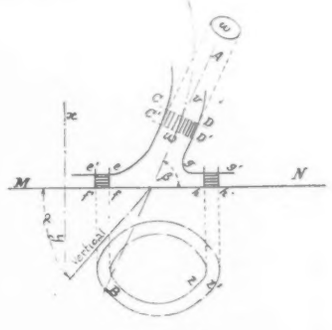


FIG. 132.

proportional to the distance from the free surface. In practice boxes are made with a constant thickness for their whole height.

Dynamic Effects of Casting.

The complexity of the shapes of a mould lead to a turbulent state which varies in every point of the cast metal. One can therefore only proceed to an approximation different from what

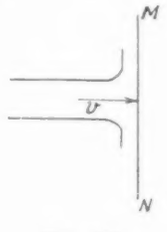


FIG. 133.

can be done in the case of hydraulic motors, where the fluid is carefully guided and under permanent control free from accidental movements.

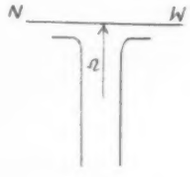


FIG. 134.

Let A, B be the direction of a down gate and M, N the trace of a plane struck by it, assuming steady conditions and parallel flow of the

(*Concluded on page* 14.)

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This Week's News in Brief.

Trade Talk.

The public examination of Mr. W. R. James, 116, Darwin Street, Birmingham, brassfounder, is to take place on July 20 next at the Court House, Corporation Street, Birmingham.

There was a net loss of seven active blast furnaces in the United States last May, leaving only 53 operating on June 1. The total production of pig-iron in May was 783,554 tons, the lowest in nearly 35 years, that is, since August, 1897.

The Foundry & Engineering Company (West Bromwich), Limited, Sandwell Road, West Bromwich, have received a repeat order from Messrs. Morris Motors, Limited, for two of their vertical continuous-core stoves.

At a recent sitting of the Falkirk Dean of Guild Court, Messrs. R. & A. Main, Limited, Gothic Iron Works, Falkirk, sought and were granted warrant to reconstruct their office and administrative buildings at the works at a cost of £5,000.

Messrs. Khatri Ahmed Abdullah & Bros., of Old Market, River Road, Karachi, India, wish to establish connections with manufacturers of foundry moulding machines, requisites, furnaces, blowers, crucibles and the like. Their agents in England are Messrs. G. Atherton & Company, Water Street, Liverpool.

The Education Committee of the Stirlingshire County Council announce that the new Technical School in Falkirk will be formally opened by Mr. W. W. M'Kechnie, of the Scottish Education Department, on Monday, September 5. The school is considered to be one of the most up to date in Scotland, and includes a fully-equipped foundry.

Falkirk Trades Holidays commenced on June 30, and, so far as the ironfoundries are concerned, the stoppage will be of an extended nature, spreading over in a number of cases to 15 days; generally, however, the restart will be about July 12. The state of trade during the first six months of the year has been exceptionally bad, and in the light-castings industry, upon the prosperity of which the town and district is so greatly dependent, there has been little or no sign of the hoped-for revival, and prospects for the future are not regarded as in any way bright.

The Board of Trade has referred to the Standing Committee an application for an Order in Council to require the marking with an indication of origin of imported bifurcated and tubular rivets of metal. Representatives of any interests substantially affected by this application who desire to be heard in opposition at the public inquiry, which will be held later by the Committee, should communicate with the Secretary, Mr. E. W. Reardon, at the Board of Trade Offices, Great George Street, London, S.W.1, as early as possible, and in any case not later than July 30 next.

There is a brighter and more hopeful tendency at the moment on the Clyde. Although the work on hand is diminishing rapidly, there is a prospect of some new contracts shortly. Numerous inquiries are being dealt with, and as these are principally for new cargo boats, it is felt that an improvement in the shipping trade is not far distant. It is hoped that at least two of the inquiries will result in definite orders within the next two or three weeks. In addition to the cargo tonnage, some of the Clyde firms are interested in the allocation of Portuguese naval work expected to be placed shortly.

Messrs. Dorman, Long & Company, Limited, have entered into a provisional agreement with the Danish Ministry for Public Works for the construction of the Storströmmen Bridge connecting Zealand and Falster in Denmark. Subject to settlement of the details, the bridge, which will be over two miles in length, will probably be started about November 1, 1932, and it is anticipated that the work will take 3½ years to complete. The steelwork will be manufactured in England at Messrs. Dorman Long's Middlesbrough works, the value of the whole contract being estimated at approximately £2,000,000 sterling.

Messrs. Lithgows, Limited, Port Glasgow, have secured an order to build a cargo steamer of about 9,000 tons deadweight for Messrs. J. & C. Harrison, Limited, London. The vessel will be similar in design to the series of Harrison boats at present under construction by Messrs. Lithgows. This is the sixth order received from the same owners since August last. The vessels embody the latest equipment to secure maximum economy, and it is claimed that they can trade profitably even at the present low freight rate. The propelling machinery is being built by Messrs. David Rowan & Company, Limited, Glasgow.

The Institution of Welding Engineers, acting in conjunction with the Acetylene and Welding Consulting Bureau, will hold a meeting on July 14, at 2.30 p.m., at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1 (by kind permission of the Council of that Institution), for the purpose of exhibiting a new film which deals with the practical applications of oxy-acetylene welding in all its branches, to be followed by an informal discussion. Free admission to the meeting can be obtained by signing the visitors' book at the entrance of the hall or by ticket, which can be obtained from the acting secretary, the Institution of Welding Engineers, 30, Red Lion Square, London, W.C.1, or from the Acetylene and Welding Consulting Bureau, 637-8, Grand Buildings, Trafalgar Square, London, W.C.2. Members, or their representatives, of all engineering and technical institutions are cordially invited to attend the above meeting.

Personal.

Mr. and Mrs. John C. Inglis, of Dumbarton, have celebrated their golden wedding. Mr. Inglis was for 50 years foreman engineer in the Leven shipyard of Messrs. William Denny & Sons, Limited, Dumbarton.

Mr. John A. Smeeton, of John A. Smeeton, Limited, engineers, of 15, Victoria Street, Westminster, London, S.W.1, desires to notify his many friends and clients that he has from June 30 terminated his agreement as sole British agent of the Badische Maschinenfabrik, and in future proposes to act as an advising engineer on foundry problems, and as an independent contractor for the design, lay-out and equipment of new foundries and foundry reconstructions.

Mr. Lawrence Ennis, who has been appointed managing director of Messrs. Dorman, Long & Company, Limited, of Middlesbrough, has been connected with the firm since 1903, when he left an important position in the United States of America to become superintendent of the Britannia constructional shops at Middlesbrough. Subsequently he was appointed general works manager of the steel plant, and following the securing of the Sydney Harbour Bridge contract in 1924, was made a director of the firm, and for eight years was in Australia superintending the work of construction. He returned to this country only a few weeks ago.

Mr. William F. Prentice, who has been appointed general manager of Messrs. Dorman, Long & Company, Limited, has had a varied career. At the conclusion of the war he was appointed a Commissioner for the Disposals Board in Germany, and later became Director-General of the Reparations Commission in Berlin. Subsequently he was appointed to the position of commercial manager of Messrs. Bolckow, Vaughan & Company, Middlesbrough, and upon that firm's amalgamation with Dorman, Long & Company, he assumed the position of sales manager to the combined companies. Last year Mr. Prentice was appointed to the position of chairman of the Management Committee of Dorman, Long & Company, and now becomes general manager. He is also a director of the Darlington Rolling Mills Company, Limited.

Contracts Open.

Colombia, July 15.—Rails, fishplates, spikes and bolts, for the Antioquia Railway. The Department of Overseas Trade. (Reference G.X. 11,598.)

Johannesburg, August 2.—35,000 boiler tubes, for the South African Railways and Harbours Board. The Department of Overseas Trade. (Reference G.X. 11,587.)

Johannesburg, August 15.—Brass piping and brass and copper sheets, for the South African Railways and Harbours Board. The Department of Overseas Trade. (Reference G.X. 11,603.)

Johannesburg, August 22.—Engine units and power transmission equipment, for the South African Railways and Harbours Board. The Department of Overseas Trade. (Reference G.X. 11,588.)

Obituary.

The Earl of Dudley, who died on Wednesday, June 29, in a London nursing home, at the age of 65, had extensive interests in the coal, iron and steel industries in Staffordshire. He had a distinguished career, having been Viceroy of Ireland and Governor-General of Australia. He is succeeded by his eldest son, Viscount Ednam, M.P., who is chairman of the Earl of Dudley's Round Oak Works, Limited, Brierley Hill, and of Baggeridge Colliery.

The death occurred very suddenly at his home in Paisley of Mr. Joseph D. Wilson, managing director of the Carntyne Steel Castings Company, Limited, Renfrew. On Wednesday, June 29, Mr. Wilson was at the works as usual on the previous day, but had two successive heart attacks later and expired. Mr. Wilson had a long connection with the steel foundry trade in Scotland; he was formerly manager of the Ayrshire Steel Foundry Company and the Diamond Steel Company, Limited, Falkirk. He was also interested in a malleable foundry in Arbroath.

Co-operation in Industry.

Mr. C. Percy Lister, managing director of Messrs. R. A. Lister & Company, Limited, of Dursley, opened a discussion on "Co-partnership and Its Part in Trade Revival" at a conference organised by the Industrial Co-partnership Association in Cambridge recently. He said that if employers could but realise something of the other fellow's point of view, we should soon, he believed, be on the road to better things. But co-partnership was a double-sided affair. The employee, too, must play his part in making it a success. If the workers could understand the meaning of the monetary restrictions now in force in so many of the markets of the world, the effect of bad or indifferent workmanship or inspection on the repute of the product they were making, the tremendous gamble with which the average trader was now confronted if he desired to do business at all, the influences of exchange and tariffs on selling prices, the high cost of securing business, the importance of strict economy, they, too, would have ample food for reflection. And if both together had more knowlege of the other's outlook and difficulties, they would soon develop new understanding and a mutual respect which, in his opinion, would very quickly remove the causes of economic and social dissension and lay the foundations of a new prosperity on an enduring basis.

Contraction, Distortion and Camber in Grey Iron Castings.

(*Concluded from page* 5.)

as a force to compress the inner and progressively solidifying metal layers.

Special mould conditions can therefore be arranged which will reduce fluid shrinkage in grey cast iron to vanishing point and at the same time produce a very dense structure in the metal generally. It will be seen that the contraction strains and stresses of grey cast iron are dual and very conflicting. Any considerations for camber allowances must take into account not only ordinary contraction, as commonly understood, but also the phenomena of post-solidification expansion peculiar to cast iron.

In conclusion, the author wishes to acknowledge his thanks and indebtedness to Mr. R. Greenwood, managing director of Messrs. Craven Brothers, Limited, Manchester, for help in the preparation of drawings, photographs, and facilities to carry out the experiments and permission to publish the camber data.

Bayonne Bridge.—Staten Island is now connected to the mainland on the north by the Bayonne Bridge, which spans the Kill van Kull with an arch 1,675 ft. in length between centres of bearings. It is claimed to be the longest arch span in the world. The total length of the steel superstructure, including approaches, is 5,780 ft., and it required 26,000 tons of steel, of which 17,000 tons are in the arch.

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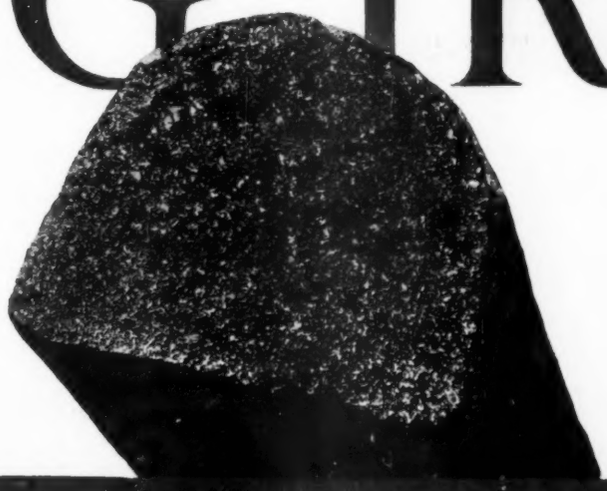

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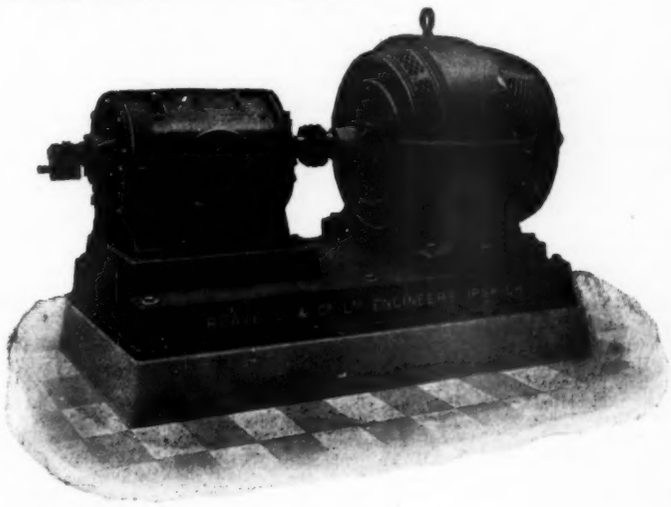

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Raw Material Markets.

Although the actual turnover in the iron and steel markets has shown little improvement, there are indications that the future holds out better possibilities. Inquiries from abroad have shown an increase, stocks in most of the overseas markets having run very low, while last month's exports of iron and steel material from the Tees were most encouraging. The re-affirmation of the import duties should encourage buying and generally strengthen confidence in the market.

Pig-Iron.

MIDDLESBROUGH.—The market has been slack during the past week, the end of the half-year and the occurrence of the holiday season in Scotland helping towards a lessened activity. In addition, there is little demand for Cleveland iron from the local foundries, many of whom are using a large percentage of scrap. The official prices for Cleveland iron are unchanged, No. 1 foundry iron being quoted at 61s. per ton, No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d. and No. 4 forge 57s. per ton, f.o.t.

A good number of small orders is being taken for East Coast hematite, but nothing of any consequence. Some of the big steelworks are becoming busier, and they should need considerable quantities of hematite. The merchants' holdings have now been greatly reduced, but the makers are still offering iron at 62s. 6d. per ton. The demand for West Coast hematite remains steady, the local steelworks being the chief consumers. Good sales are made in the Midlands, while South Wales is an improving market. Bessemer mixed numbers remain at 66s. per ton at works.

LANCASHIRE.—Deliveries in this district are maintained at a fairly steady level, in spite of the continued depression in some sections of the consuming industries. Large supplies of scrap are still offered at low prices. Quotations are steady at 67s. per ton for Staffordshire and Derbyshire brands of No. 3 iron for delivery to consumers in the Manchester zone, with North-East Coast makes at around the same figure, Northamptonshire at 65s. 6d., Derbyshire forge iron at 62s., Scottish foundry at from about 84s. 6d. to 85s. 6d., and West Coast hematite at around 81s. Indian iron continues to be offered at very low prices.

MIDLANDS.—A meeting of the Central Pig-Iron Producers' Association was held last week, but no change in prices was made. They remain at 62s. 6d. for No. 3 Northants, and 66s. for North Staffs, Derbyshire and Lincolnshire No. 3, including delivery to Birmingham and Black Country stations. Conditions are very slow in the heavy engineering industries, while even the light foundries are experiencing a very irregular trade.

SCOTLAND.—The occurrence of the holiday season has largely brought business to a standstill. Export business remains slow. The official price of Scottish foundry iron remains at 69s. 6d. per ton f.o.t. furnaces, with a minimum of 2s. 6d. extra for No. 1, the number of blast furnaces in operation being unchanged at three on hematite and three on foundry. No. 3 Middlesbrough is obtainable at 55s. 6d. per ton f.o.t. Falkirk, with Northamptonshire iron at slightly less. There is no iron coming in from the Continent.

Coke.

The situation in the foundry-coke market is little changed. Hand-to-mouth buying remains the general rule, although forward buying has been reported in one or two isolated instances. Prices remain stationary. Best Durham brands are offered at 37s. 6d. per ton delivered Birmingham and district, with other grades at 2s. 6d. less. Welsh quotations vary according to analysis and tonnage from 30s. to 45s. delivered.

Steel.

The demand for finished steel is very irregular, the heavier sections being particularly depressed. A slightly heavier inquiry has been forthcoming from the overseas markets. There is a steady demand for tinplates, but business in galvanised sheets remains very poor. Consumers are making little demand for semis, and the low quotations made by the Continental works are finding little or no response.

Scrap.

Business in the Cleveland scrap-iron market has shown no improvement, owing to the continued irregularity of work at the foundries in the district. Ordinary quality remains on offer at 36s. per ton, while good machinery metal in handy sizes is worth no more than 37s. Light castings are nominally at 32s. The Midlands foundries are similarly situated, and the demand for scrap is limited. Heavy machinery scrap in cupola sizes is offered at 45s. delivered, heavy pipe and plate scrap at 40s. to 42s. 6d. delivered, and clean light scrap at 35s. delivered. Business remains very limited in South Wales. In Scotland, deliveries have been held up for the holidays, and business is partly at a standstill. Many of the works still hold large stocks of material, and, with the heavy industries in their present state, it is difficult to see any early recovery in the demand. First quality machinery, suitable for cupolas and in pieces not exceeding 1 cwt., can be obtained at 45s. to 46s., while for ordinary cast-iron scrap to the same specification the price is about 41s. 3d. Light cast iron is unchanged at 32s. 6d. per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—The most important development of the week has, of course, been the breakaway of important producers from Copper Exporters, Inc., the international sales agency. At the moment, this means the abandonment of price control and the virtual establishment of a free market, with resultant benefit to the consuming industries. The main cause has been the prohibitive duty put on copper imports into the United States. There is talk of forming a new European sales agency with non-U.S.A. producers as members. Buyers have been holding back to watch developments, and that and the increasing competition among outside interests has brought prices down to about 5 cents per lb. c.i.f.—a new low level.

Closing quotations :—

Cash.—Thursday, £25 8s. 9d. to £25 11s. 3d.; Friday, £25 12s. 6d. to £25 13s. 9d.; Monday, £26 7s. 6d. to £26 10s.; Tuesday, £27 2s. 6d. to £27 3s. 9d.; Wednesday, £27 5s. to £27 7s. 6d.

Three Months.—Thursday, £25 3s. 9d. to £25 5s.; Friday, £25 5s. to £25 7s. 6d.; Monday, £25 12s. 6d. to £25 15s.; Tuesday, £26 8s. 9d. to £26 10s.; Wednesday, £26 15s. to £26 17s. 6d.

Tin.—Standard has risen over £10 per ton during the past week, mainly owing to the continued fall in the exchange. There has been a slight set-back in the last day or two, due to the usual profit-taking, but the market seems much stronger. The end-of-June statistics showed a reduction of over 1,000 tons in visible supplies, and this should be considerably improved upon during this and the following month, when there is a total cessation of production. The tin market, however, is still handicapped by a poor demand from consumers, particularly in America.

Official closing prices :—

Cash.—Thursday, £117 5s. to £117 10s.; Friday, £123 15s. to £124; Monday, £121 10s. to £121 15s.; Tuesday, £123 12s. 6d. to £123 17s. 6d.; Wednesday, £124 to £124 5s.

Three Months.—Thursday, £118 15s. to £119; Friday, £125 5s. to £125 10s.; Monday, £123 5s. to £123 10s.; Tuesday, £125 7s. 6d. to £125 10s.; Wednesday, £125 5s. to £125 10s.

Spelter.—There has been a slight increase in the demand from consumers, while holders have also not been so ready to offer. The statistical position continues to show improvement. In August, 1931, when the Cartel became effective, members' stocks totalled 203,673 metric tons, but by mid-June there had been a reduction of about 35,000 metric tons.

Daily fluctuations :—

Ordinary.—Thursday, £11 6s. 3d.; Friday, £11 8s 9d.; Monday, £11 8s. 9d.; Tuesday, £11 15s.; Wednesday, £11 13s. 9d.

Lead.—There has been a small, but steady, demand from consumers throughout the week. The depression on the Continent among the lead-consuming industries remains unrelieved. Russia also, once a good customer, is now largely off the market, owing to contraction of buying power.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £9 8s. 9d.; Friday, £9 13s. 9d.; Monday, £10; Tuesday, £10 5s.; Wednesday, £10.

Introduction to the Study of Moulding and Casting.

(*Concluded from page* 10.)

liquid (Fig. 132). Let v be the velocity of flow at the section C, D of area ω. The stream is split up and forms a cylindrical nappe or sheet of height e, f, and it will be assumed that the liquid streams parallel to M, N.

During an infinitely small interval of time d, t, C, D goes to C′, D′, e, f to e', f' and g, h to g', h'. Let us apply to the mass CD $eg\ gh$ the theory of momentum along the axis x, y normal to M, N. Since the conditions are steady, it is not necessary to consider the mass C′D′ $ef\ gh$, which is common.

If δ be the specific gravity of the cast metal, the mass CD C′D′ is $\frac{\delta}{g} . \omega . v . dt$, the velocity projected on x, y is $v \sin \beta$.

The increased momentum, for the time dt is equal to $\frac{\delta}{g} \omega . v^2 \sin \beta . dt$.

The impulses exerted are F dt for the reaction of M, N and $-$ P $\sin \alpha$ dt for the weight, which will be neglected; then

$$F = \omega . v^2 \sin \beta \frac{\delta}{g} .$$

But $v^2 = 2gh$.

Therefore $F = 2 \omega . h . \delta . \sin \beta$.

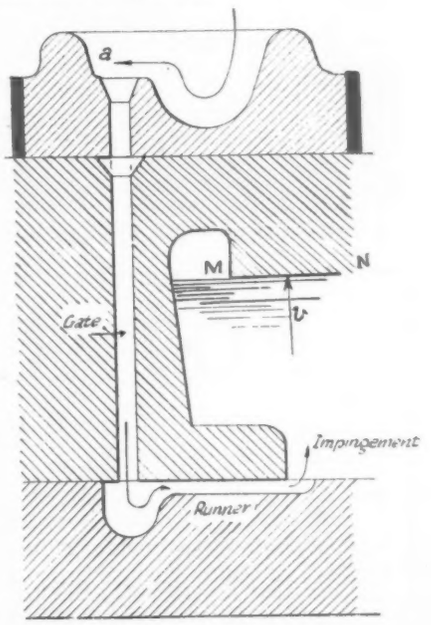


FIG. 135.

The dynamic effect, in other words the force with which the stream strikes the plane, is measured by twice the static load multiplied by the sine of the angle of impact. It follows that if B = 90 deg., the shock is exactly measured by double the static effect, whether the stream is descending (top pouring) or rising (bottom running). In the latter case, v should be as small as possible, since the stream has the same section as the mould.

Conclusion.

The study of the static and dynamic effects has made apparent the forces and couples which have to be resisted by moulds, core and projecting parts. It is obvious that sand alone, even when dried, cannot be expected to withstand these. Thus, the solidity of the structure can only be ensured by the use of reinforcements, such as grids, judiciously planned and calculated in accordance with the methods employed in the study of the strength of materials, joined together or placed one over the other and secured to the box and to anchorages.

Sterling

MOULDING BOXES

Stand up to the exacting Requirements of the Modern Foundry

because

They are made from Rolled Steel

In the course of a day's work each box part must be handled several times. For quantity production, therefore, light moulding boxes are essential.

To withstand the brunt of rapid handling and the heavy pressures of the modern moulding machine, the box must be strong, rigid and unbreakable.

For the production of castings true to pattern free from fins and crossed joints, accurate moulding boxes are not only necessary but vital.

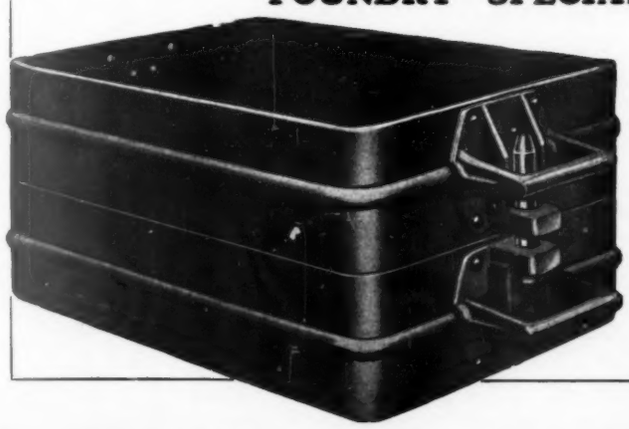
In no other type of moulding box will you find such uniform accuracy of pins and parting faces, nor just that correct ratio of the necessary factors to ensure long life without undue weight.

LET US HAVE YOUR ENQUIRY FOR YOUR NEXT LOT OF BOXES.

STERLING

FOUNDRY SPECIALTIES LTD.,

BEDFORD.



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Code: Western Union.

London Office:
13, VICTORIA STREET, S.W.1.

YOU CAN RELY ON THE NAME

WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	27	5	0
Three months	26	15	0
Electrolytic	30	10	0
Tough	28	15	0
Best selected	29	5	0
Sheets	59	0	0
India	41	0	0
Wire bars	31	15	0
Do., Aug.	31	12	6
Do., Sept.	31	10	0
Ingot bars	31	15	0
H.C. wire rods	34	10	0
Off. av. cash, June	26	18	4 2/5
Do., 3 mths., June	26	14	8 1/4
Do., Sttlmnt., June	26	18	7 7/11
Do., Electro, June	31	5	2 5/11
Do., B.S., June	30	4	4 1/2
Do., wire bars, June	31	13	7 7/11
Solid drawn tubes			9 1/2d.
Brazed tubes			9 1/2d.
Wire			6 1/2d.

BRASS.

Solid drawn tubes	9d.
Brazed tubes	11d.
Rods, drawn	7 1/2d.
Rods, extd. or rlld.	4 3/4d.
Sheets to 10 w.g.	7 1/2d.
Wire	7 1/2d.
Rolled metal	6 7/8d.
Yellow metal rods	4 3/4d.
Do. 4 × 4 Squares	5 3/4d.
Do. 4 × 3 Sheets	5 3/4d.

TIN.

	£	s.	d.
Standard cash	124	0	0
Three months	125	5	0
English	125	10	0
Bars	127	10	0
Straits	128	12	6
Australian	126	12	6
Eastern	129	0	0
Banca (nom.)	133	12	6
Off. av. cash, June	114	12	11
Do., 3 mths., June	116	18	5 3/4
Do., Sttlmt., June	114	13	1 1/2

SPELTER.

	£	s.	d.
Ordinary	11	13	9
Remelted	10	15	0
Hard	9	10	0
Electro 99.9	14	5	0
English	13	0	0
India	11	10	0
Zinc dust	19	0	0
Zinc ashes	1	15	0
Off. aver., June	11	14	1 17/32
Aver. spot, June	11	10	11 13/32

LEAD.

	£	s.	d.
Soft foreign ppt.	10	0	0
Empire	10	17	6
English	12	0	0
Off. average, June	9	15	0 1/4
Average spot, June	9	12	1 10/11

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	22	10	0
Do., V.M. ex-whf.	20	0	0
Rods	26	0	0
Boiler plates			—
Battery plates			—

ANTIMONY.

English	35 0 0 to 42 10 0
Chinese	21 10 0
Crude	16 0 0

QUICKSILVER.

	£	s.	d.
Quicksilver	10	15	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	8 5 0
45/50%	13 15 0
75%	19 0 0
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% c. free, of Mo.	6/3 per lb.
Ferro-titanium—	
23/25% carbon-free	11d. lb.
Ferro-phosphorus, 20/25%	£21 0 0
Ferro-tungsten—	
80/85%	2/- lb.
Tungsten metal powder—	
98/99%	2/3½ lb.
Ferro-chrome—	
2/4% car.	£27 15 0
4/6% car.	£25 0 0
6/8% car.	£24 10 0
8/10% car.	£23 15 0
Ferro-chrome—	
Max. 2% car.	£37 0 0
Max. 1% car.	£46 17 6
Max. 0.70% car.	£48 5 0
70% carbon-free	1/1 lb.
Nickel—80/99.5%	£230 to £235
"F" nickel shot	£207 0 0
Ferro-cobalt	8/- lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/9 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to £11 5 0
76/80% packed	£11 15 0 to £12 5 0
76/80% export	(nom.) £9 0 0
Metallic manganese—	
94/96% carbon-free	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten 2s. 0d.
Finished bars, 18% tungsten 2s. 9d.
Per lb. net, d/d buyers' works.

Extras—
Rounds and squares, 3 in. and over 4d. lb.
Rounds and squares, under ½ in. to ¼ in. 3d. lb.
Do., under ¼ in. to 7/16 in. 1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅜ in. 3d. lb.
Do., under ¼ in. × ¼ in. 1/- lb.
Bevels of approved sizes and sections 6d. lb.
Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel					1	17	6
Bundled steel and shrngs.	1	14	0	to	1	17	0
Mixed iron and steel	1	15	0	to	1	16	0
Heavy cast iron	1	19	0	to	2	0	0
Good machinery for foundries					2	2	6
Cleveland—							
Heavy steel					1	15	0
Steel turnings					1	10	0
Cast-iron borings					1	2	6
Heavy forge					2	10	0
W.I. piling scrap					2	2	6
Cast-iron scrap	1	16	0	to	1	17	0
Midlands—							
Light cast-iron scrap					1	15	0
Heavy wrought iron					2	7	6
Steel turnings, f.o.r.					0	18	6
Scotland—							
Heavy steel					1	15	0
Ordinary cast iron					2	1	6
Engineers' turnings					1	8	0
Cast-iron borings					1	10	0
Wrought-iron piling					2	1	6
Heavy machinery					2	5	0

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	23	0	0
Brass	15	0	0
Lead (less usual draft)	7	0	0
Tea lead	5	0	0
Zinc	6	0	0
New aluminium cuttings	72	0	0
Brasiery copper	19	0	0
Gunmetal	19	0	0
Hollow pewter	70	0	0
Shaped black pewter	50	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	61/-
Foundry No. 3	58/6
Foundry No. 4	57/6
Forge No. 4	57/-
Hematite No. 1	63/-
Hematite M/Nos.	62/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	72/-
d/d Birm.	84/6
Malleable iron d/d Birm.	117/6
Midlands—	
Staffs common*	—
No. 4 forge*	61/-
No. 3 fdry.*	66/-
Shrops basic	—
Cold blast, ord.	—
roll iron	—
Northants forge*	57/6
fdry. No. 3*	62/6
fdry. No. 1*	65/6
Derbyshire forge*	61/-
fdry. No. 3*	66/-
fdry. No. 1*	69/-
basic*	—

*d/d Black Country dist.

Scotland—	
Foundry No. 1	72/-
No. 3	69/6
Hem. M/Nos. d/d	68/6
Sheffield (d/d district)—	
Derby forge	58/6
fdry. No. 3	63/6
Lincs forge	—
fdry. No. 3	63/6
E.C. hematite	74/6
W.C. hematite	83/6
Lancashire (d/d eq. Man.)—	
Derby forge	62/-
fdry. No. 3	67/-
Staffs fdry. No. 3	67/-
Northants fdry. No. 3	65/6
Cleveland fdry. No. 3	67/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	84/6 to 85/6
Clyde, No. 3	84/6 to 85/6
Monkland, No. 3	84/6 to 85/6
Summerlee, No. 3	84/6 to 85/6
Eglinton, No. 3	84/6 to 85/6
Gartsherrie, No. 3	84/6 to 85/6
Shotts, No. 3	84/6 to 85/6

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	9	5	0	to	9	15	0
Nut and bolt iron	7	15	0	to	8	10	0
Hoops	10	10	0	to	12	0	0
Marked bars (Staffs) f.o.t.					12	0	0
Gas strip	10	10	0	to	12	0	0
Bolts and nuts, ¾ in. × 4 in.					12	0	0
Steel—							
Plates, ship, etc.	8	15	0	to	8	17	6
Boiler plts.	8	7	6	to	9	5	0
Chequer plts.					10	7	6
Angles					8	7	6
Tees					9	7	6
Joists					8	15	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ⅜ in. (Untested)					6	12	6 & up.
Flats—8 in. wide and over					8	12	6
„ under 8 in. and over 5 in.					8	17	6
Rails, heavy	8	5	0	to	8	10	0
Fishplates					12	0	0
Hoops (Staffs)					9	10	0
Black sheets, 24g.	8	0	0	to	8	10	0
Galv. cor. shts.	9	5	0	to	10	0	0
Galv. flat shts.	9	15	0	to	11	0	0
Galv. fencing wire, 8g. plain					12	7	6
Billets, soft	4	17	6	to	5	7	6
Billets, hard					6	12	6
Sheet bars	4	15	0	to	5	5	0
Tin bars					4	15	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	11½d.
Rods	10½d.
Tubes	16d.
Castings	12d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	14.84
No. 2 foundry, Valley	14.50
No. 2 foundry, Birm.	11.00
Basic	15.89
Bessemer	16.89
Malleable	16.89
Grey forge	16.39
Ferro-mang. 80%, seaboard	68.00
O.-h. rails, h'y, at mill	43.00
Billets	26.00
Sheet bars	26.00
Wire rods	37.00
	Cents.
Iron bars, Phila.	2.11
Steel bars	1.60
Tank plates	1.60
Beams, etc.	1.60
Skelp, grooved steel	1.60
Skelp, sheared steel	1.60
Steel hoops	1.65
Sheets, black, No. 24	2.20
Sheets, galv., No. 24	2.85
Wire nails	1.95
Plain wire	2.20
Barbed wire, galv.	2.60
Tinplates, 100-lb. box	$4.75

COKE (at ovens).

Welsh foundry	20/- to 22/6
„ furnace	16/- to 16/6
Durham and Northumberland—	
„ foundry	21/- to 25/-
„ furnace	13/- to 13/6
Midlands, foundry	—
„ furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	14/9 to 15/3	
„	28×20 „	29/6 to 30/6	
„	20×10 „	—	
„	18¾×14 „	—	
C.W.	20×14 „	—	
„	28×20 „	—	
„	20×10 „	—	
„	18¾×14 „	—	

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	0	0
Bars, hammered, basis	£16	10	0	to	£17	0	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	5	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£18	0	0	to	£23	0	0
Bars and rods dead soft, st'l	£10	0	0	to	£12	0	0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
June	30 ..	25	8	9	dec. 12/6
July	1 ..	25	12	6	inc. 3/9
„	4 ..	26	7	6	„ 15/–
„	5 ..	27	2	6	„ 15/–
„	6 ..	27	5	0	„ 2/6

Electrolytic Copper.

		£	s.	d.	
June	30 ..	30	0	0	dec. 10/–
July	1 ..	29	10	0	„ 10/–
„	4 ..	30	10	0	inc. 20/–
„	5 ..	30	10	0	No change
„	6 ..	30	10	0	„ „

Standard Tin (cash).

		£	s.	d.	
June	30 ..	117	5	0	inc. 50/–
July	1 ..	123	15	0	„ 130/–
„	4 ..	121	10	0	dec. 45/–
„	5 ..	123	12	6	inc. 42/6
„	6 ..	124	0	0	„ 7/6

Tin (English ingots).

		£	s.	d.	
June	30 ..	119	0	0	inc. 50/–
July	1 ..	125	10	0	„ 130/–
„	4 ..	123	0	0	dec. 50/–
„	5 ..	125	10	0	inc. 50/–
„	6 ..	125	10	0	No change

Spelter (ordinary).

		£	s.	d.	
June	30 ..	11	6	3	inc. 2/6
July	1 ..	11	8	9	„ 2/6
„	4 ..	11	8	9	No change
„	5 ..	11	15	0	inc. 6/3
„	6 ..	11	13	9	dec. 1/3

Spelter (Electro, 99.9 per cent.).

		£	s.	d.	
June	30 ..	13	12	6	dec. 2/6
July	1 ..	13	17	6	inc. 5/–
„	4 ..	13	17	6	No change
„	5 ..	14	5	0	inc. 7/6
„	6 ..	14	5	0	No change

Zinc Sheets (English).

		£	s.	d.	
June	30 ..	22	10	0	No change
July	1 ..	22	10	0	„ „
„	4 ..	22	10	0	„ „
„	5 ..	22	10	0	„ „
„	6 ..	22	10	0	„ „

Lead (English).

		£	s.	d.	
June	30 ..	11	5	0	No change
July	1 ..	11	15	0	inc. 10/–
„	4 ..	12	0	0	„ 5/–
„	5 ..	12	5	0	„ 5/–
„	6 ..	12	0	0	dec. 5/–

AVERAGE MONTHLY PRICES OF DERBYSHIRE NO. 3 FOUNDRY AT MANCHESTER.

Year.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1896	2 5 6	2 6 0	2 6 0	2 6 0	2 6 0	2 5 6	2 5 0	2 5 0	2 5 0	2 6 0	2 7 0	2 8 6	2 5 11½
1897	2 10 0	2 11 0	2 9 0	2 8 6	2 8 0	2 7 0	2 7 0	2 7 0	2 6 0	2 6 0	2 6 6	2 7 6	2 7 9½
1898	2 7 6	2 8 0	2 8 0	2 8 0	2 8 6	2 10 0	2 10 0	2 10 0	2 10 0	2 11 0	2 14 0	2 14 9	2 9 11
1899	2 13 0	2 14 0	2 14 0	2 14 0	3 0 0	3 2 0	3 13 0	3 16 6	3 15 0	3 16 6	3 16 6	4 0 0	3 6 2½
1900	4 0 0	4 0 0	4 0 0	4 1 6	4 1 0	3 18 0	3 13 6	3 12 6	3 11 0	3 11 0	3 9 6	3 8 0	3 15 5
1901	2 18 6	2 17 0	2 15 0	2 15 0	2 14 0	2 13 9	2 13 6	2 13 6	2 14 6	2 13 0	2 12 6	2 16 6	2 14 3½
1902	2 17 6	2 17 6	2 15 6	2 16 9	2 16 6	2 16 6	2 16 6	2 17 0	2 18 6	2 18 6	2 17 6	2 17 6	2 17 1½
1903	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1904	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6	2 17 6
1905	2 13 0	2 13 0	2 11 6	2 12 6	2 12 0	2 12 0	2 12 3	2 12 3	2 14 0	2 16 6	3 0 0	3 0 6	2 14 1
1906	3 2 0	3 5 0	3 3 0	3 0 6	2 17 0	2 18 6	2 18 0	2 16 6	2 19 0	3 0 6	3 1 6	3 7 0	3 0 8½
1907	3 7 0	3 7 0	3 5 0	3 2 0	3 4 0	3 8 0	3 6 0	3 5 0	3 4 0	3 2 6	3 1 0	2 18 6	3 4 2
1908	2 15 0	2 14 6	2 14 6	2 15 6	2 14 0	2 13 0	2 13 0	2 11 6	2 12 6	2 13 0	2 12	2 12 6	2 13 5½
1909	2 13 0	2 12 6	2 11 6	2 12 0	2 12 6	2 12 6	2 12 0	2 12 6	2 14 6	2 15 0	2 14 6	2 14 0	2 13 0½
1910	2 13 9	2 14 0	2 14 0	2 14 4	2 15 0	2 15 0	2 14 9	2 15 0	2 15 0	2 15 0	2 15 0	2 15 0	2 14 7½
1911	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 16 0	2 14 6	2 15 0	2 15 0	2 15 8½
1912	2 17 4½	2 17 6	2 17 6	3 1 1½	3 2 6	3 3 9	3 6 3	3 7 6	3 10 10½	3 12 6	3 13 3½	3 14 6	3 5 4
1913	3 15 7	3 15 0	3 11 10½	3 11 4½	3 10 2½	3 6 10½	3 4 2½	3 2 9	3 1 9	3 1 0	2 19 3	2 17 2½	3 6 5
1914	2 17 2½	2 18 0	2 18 0	2 17 0	2 17 0	2 16 7½	2 16 0	3 2 10	3 1 0	2 19 9½	2 16 11½	2 18 1½	2 18 2
1915	3 1 2	3 3 11	3 5 9	3 18 8½	3 13 7	3 14 1	3 15 0	3 13 3	3 12 0½	3 11 1	3 14 0	4 3 3	3 12 2½
1916	4 4 6½	4 11 6	4 11 6½	4 7 6	4 7 6	4 7 6	4 10 0	4 12 10	4 12 6	4 12 6	4 12 6	4 12 6	4 8 6½
1917	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1918	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6	4 12 6
1919	4 12 6	4 12 6	4 12 6	4 12 6	7 2 6	7 5 0	8 8 5	9 0 0	9 0 0	9 0 0	9 0 0	9 0 0	7 3 10
1920	9 13 9	10 0 0	10 5 3	10 15 3	11 10 0	12 2 6	12 5 0	13 1 3	14 7 6	14 5 0	14 5 0	14 5 0	12 12 1½
1921	12 11 8	10 8 9	9 2 6	8 2 0	8 0 0	8 0 0	8 0 0	8 1 8	7 4 0	6 7 6	5 7 6	4 16 10	8 0 2
1922	5 5 0	4 17 6	4 15 0	4 15 0	4 12 6	4 12 6	4 12 6	4 12 6	4 11 3	4 10 0	4 10 0	4 10 0	4 13 7½
1923	4 12 8½	5 0 2	6 2 6	6 8 7½	6 2 5	5 11 9	5 9 1½	5 4 0	5 0 0	5 0 9	5 0 7	5 2 9	5 7 11½
1924	5 3 0	5 3 0	5 3 0	5 3 0	5 2 10	5 1 3	4 17 11	4 15 6	4 13 6	4 10 1½	4 10 0	4 10 3	4 17 9½
1925	4 10 0	4 9 0	4 6 9	4 5 2½	4 3 0	4 0 1½	4 17 1½	3 15 7½	3 14 3½	3 13 4½	3 13 4½	3 13 2½	4 1 9
1926	3 14 9	3 15 3	3 15 6	3 15 3½	3 17 6	4 5 9	4 16 9	*	*	*	*	4 12 6	4 0 1½
1927	4 13 9½	4 13 3	4 11 1½	4 9 4½	4 6 1½	3 19 1½	3 16 1½	3 15 6	3 13 4½	3 13 4½	3 14 0	3 13 6½	4 1 6½
1928	3 13 2½	3 12 3½	3 12 3	3 12 3	3 11 6	3 10 0	3 8 3	3 7 8½	3 7 6	3 7 9½	3 8 3	3 7 6	3 9 10½
1929	3 8 3½	3 10 4½	3 10 10½	3 11 0	3 11 2½	3 12 0	3 12 4½	3 14 6	3 15 1½	3 17 0	3 17 0	3 17 0	3 13 1½
1930	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 17 0	3 15 0	3 12 0	3 12 0	3 12 0	3 10 1½	3 9 6	3 14 4½
1931	3 9 6	3 9 6	3 9 6	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 10
1932	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	3 7 0	—	—	—	—	—	—	—

* No prices available during strike period.

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